Digitized by the Internet Archive
in 2010 with funding from
University of Toronto

http://www.archive.org/details/transactions04cana

MR. CHARLES FERGIE, M.E.,

Westville, N.S.,

PRESIDENT 1901–2.

THE LATE Dr. GEORGE M. DAWSON,

Director of the Geological Survey of Canada.

THE LATE JAS. F. LEWIS,
Sherbrooke, Que.

and Metallurgy
Transactions

THE JOURNAL

OF THE

Canadian Mining Institute

1901

CONTAINING THE

PAPERS AND PROCEEDINGS OF THE MEETINGS
AND EXCURSIONS OF THE INSTITUTE

Held in Cape Breton and Newfoundland
in August, 1900

AND THE

ANNUAL GENERAL MEETINGS

Held at Montreal in March, 1901

VOLUME IV.

EDITED BY THE SECRETARY AND
PUBLISHED BY AUTHORITY OF THE COUNCIL

OTTAWA, JUNE, 1901

592588
3.9.54

NOTICE.

The Institute as a body shall not be responsible for the statements or opinions advanced in the papers which may be read, or in the discussions which may take place at its meetings.

—*Par. XI., Constitution and By-Laws.*

NOTICES TO MEMBERS.

INSTITUTION OF MINING ENGINEERS.

The Council has made arrangements whereby members of The Canadian Mining Institute are permitted to purchase copies of the Transactions of the Institution of Mining Engineers of Great Britain at the special rates named below:—

Vols. 1, 2 and 3, 25 shillings each, post free.
Vol. 4 to date, 10 shillings each, post paid.

All applications and remittances for these copies should be addressed to the Secretary.

SUBSCRIPTIONS.

Members are reminded that subscriptions for the ensuing year were payable at the Annual Meeting, 1st March last, and arrears should be remitted without delay to the Treasurer, Mr. John Stevenson Brown, Temple Bdg., Montreal.

LIBRARY AND READING ROOM.

The Library and Reading Room (Room IV., Windsor Hotel, Montreal) is open daily for the use of members from 10 a.m. to 6 p.m.

CHANGE OF RESIDENCE.

The Secretary will be obliged if members will notify him promptly of any change in their address.

B. T. A. BELL, Secretary.

GENERAL INDEX.

MEETINGS :— PAGE

Annual General 68–80

Cape Breton, Newfoundland 3–67

EXCURSIONS :—

To Bras d'Or Lakes 33

" Halifax 39

" Louisburg 32

" Newfoundland 60

" Pictou County 33

" Pictou Harbour 35

" Quebec 8

" Sherbrooke 4

" Sydney 10

" Sydney Mines 61

" Thetford Mines 7

" Waverley 53

PAPERS :—

1. Notes on Gold Milling Practice at the Athabasca Mine, Nelson, B.C. 83
   By E. Nelson Fell, A.R.S.M., Nelson.
2. Notes on the Magnetic Iron Sand of the North Shore of the St. Lawrence 91
   By J. Obalski, M.E., Quebec.
3. A Simple and Convenient Instrument for Mine Surveys 99
   By Frank Robbins, M.E., Kimberley, B.C.
4. Rope Driven *versus* Direct Driven Colliery Ventilating Fans 107
   By Francis T. Peacock, Montreal.
5. Treatment of Auriferous Mispickel Ores 113
   By P. Kirkgaard, Deloro, Ont.
6. Leaching Copper Ores by Sulphurous Acid 123
   By E. P. Jennings, M.E., Salt Lake City.
7. Across the Pitch *versus* Up the Pitch 126
   By O. E. S. Whiteside, M.E., Anthracite.
8. Shipping Coal by the Aerial Wire Rope System at Port Morien, C.B. 131
   By Joseph G. S. Hudson, M.E., Port Morien.
9. Coal, Gas, and Coke as Domestic Fuels 135
   By F. H. Mason, F.C.S., Halifax, N.S.
10. Treatment of Auriferous Mispickel Ores at Deloro, Ontario 143
    By Sidney B. Wright, F.I.C., Deloro, Ont.

PAPERS—*Continued.*

11. The Composition of some Canadian Limestones. (*a*) For Calcium Carbide. (*b*) For Chemical Wood Pulp. (*c*) For Portland Cement 152
By J. T. Donald, M.A., Montreal.

12. The Coal Creek Colliery of the Crow's Nest Pass Coal Co..... 155
By C. V. Corless, McGill University, Montreal.

13. Algoma Mining Freaks..... 174
By Charles Brent, M.E., Rat Portage.

14. The Analysis of Corundum and of Corundum Rock 180
By Dr. W. L. Goodwin, Kingston, Ont.

15. Notes on the Oregon Nickel Prospects 184
By Dr. A. R. Ledoux, New York.

16. The Duty of Stamp Mills in Crushing and Amalgamation..... 190
By Courtenay De Kalb M.E., Kingston, Ont.

17. Notes on the Iron Ore Deposits of Bilboa, Northern Spain..... 196
By Frank D. Adams, M.Sc., Ph.D., F.G.S.

18. Notes on Crushing and Sizing in the Ore-Dressing Laboratories of McGill University..... 205
By Dr. J. Bonsall Porter, Montreal.

19. Determination of Lead in Ores by Fire Assay 224
By Douglas Lay, A.R.S.M., Kimberley, B.C.

20. Pioneer Work in the Crow's Nest Coal Areas 230
By Wm. Blakemore, M.E., Fernie, B.C.

21. Company Law..... 244
By J. M. Clark, M.A., LL.B., K.C., Toronto, Ont.

22. Concentration of Argentiferous Galena as carried on at Helena Frisco Consolidated Company's Mills, Gem, Idaho, U.S.A..... 254
By W. Muir Edwards, Montreal.

23. The Iron Ore Fields of Ontario 265
By Prof. Willet G. Millar, School of Mining, Kingston, Ont.

APPENDIX:—

Secretary's Report 287
Officers and Council, 1901..... 316
Deceased Members..... 318
List of Members 319

INDEX TO CONTENTS.

Acadia Colliery, 34.
Across the Pitch *vs.* Up the Pitch, 126.
Adams, Dr. Frank D.: on "The Iron Ore Deposits of Bilboa, 196.
Algoma Mining Freaks, 174.
American Institute of Mining Engineers, Halifax Meeting, 39.
Asbestos Mining in Quebec, 7, 304.
Auriferous Mispickel Ores, The Treatment of, 113–143.

Bell, B. T. A.: Remarks, Sydney Meeting, 20; Halifax Harbour Excursion, 53; Secretary's Report, 287; on "Mining Progress in Canada in 1900," 292.
Bell Island Iron Mines, 62.
Blakemore, Wm.: on "Pioneer Work in the Crow's Nest Coal Areas," 230; remarks, Secretary's Report, 75.
Bounties paid by Dominion Government:—
(*a*) On Pig Iron, 312.
(*b*) On Puddled Bars, 313.
(*c*) On Steel Ingots, 313.
(*d*) On Silver, 313.
Bras d'Or Lake Excursion, 33.
Brent, Charles: on "Algoma Mining Freaks," 174.
British Columbia, Mining in, during 1900, 293.

Caledonia Colliery, 29.
Cape Breton Meeting, 10–33.
Cast-Iron, Methods of Testing, 41.
Chromite, Production of, Quebec, 308.
Civil Engineers' Bill, 73.
Clark, J. M.: on "Company Law," 244.
Coal Creek Colliery, 155.
Coal, Gas, and Coke as Domestic Fuels, 135.
Coal Markets in Manitoba and North-West Territories, 299.
Coal Mining in Alberta, 298.
Coal Mining in Assiniboia, 299.
Coal Mining in Cape Breton, 21.
Coal Mining in Nova Scotia, 21.
Coal Mining in the Yukon, 296.
Coal Washing in Cape Breton, 29.
Composition of some Canadian Limestones, 152.
Concentration of Argentiferous Galena at Gem, Idaho. 255.
Copper Mining in British Columbia, 295.
Copper Mining in Nova Scotia, 311.
Copper Mining in Ontario, 300.
Copper Mining in Quebec, 308.
Corless, C. V.: on "The Coal Creek Colliery of the Crow's Nest Pass Coal Co.," 155.
Corundum and Corundum Rock, Analysis of, 180.
Crushing and Sizing at McGill Laboratories, 205.

Dawson, The late Dr. G. M., 71.
Deep Level Shafts on the Rand, 40.
DeKalb, Courtenay: on "The Duty of Stamp Mills in Crushing and Amalgamation," 190.
Determination of Lead in Ores by Fire Assay, 224.
Dominion Coal Company's plant, 15-27.
Dominion Iron and Steel Co's plant at Sydney, C.B., 11–24.
Dominion No. I Colliery, 27.
Dominion No. II Colliery, 28.
Dominion No. III Colliery, 29.
Dominion No. IV Colliery, 29.
Donald, J. T.: on "The Composition of some Canadian Limestones," 152.
Douglas, Dr. James: address at Sherbrooke, 5; at Quebec, 9; at Sydney, 13, 17; at Glace Bay, 31; Bras d'Or Lakes, 33; Pictou, 37; at Waverley, 54.
Drummond Colliery, 34.
Duty of Stamp Mills in Crushing and Amalgamation, 190.

Edwards, W. Muir: on "Concentration of Argentiferous Galena at Gem, Idaho," 254.
Excursions:—
Bras d'Or Lakes, 33.
Halifax, 39.

Excursions—*Continued.*
Louisburg, 32.
Newfoundland, 60.
Pictou County, 33.
Pictou Harbour, 35.
Quebec, 8.
Sherbrooke, 4.
Sydney, 10.
Sydney Mines, 61.
Thetford Mines, 7.
Waverley, 53.

Fell, E. Nelson: on "Gold Milling at the Athabasca Mine, Nelson, B.C.," 83.
Fergie, Chas.: remarks at Sydney, 15.
Fielding, Hon. W. S.: remarks at Waverley, 57.
Fraser, D. C.: address, Pictou County Excursion, 37.
Fraser, Graham: remarks at Sydney meeting, 26.

Geological Survey Staff Salaries, 71.
Gilpin, Dr.: on "Gold Mining in Nova Scotia," 46.
Gold Dredging in B.C., 294.
Gold Dredging in the Yukon and N.W.T., 297.
Gold Milling at Athabasca Mine, B.C., 83.
Gold Mining in Nova Scotia, 44.
Gold Mining in Ontario, 302.
Gold Mining in Quebec, 308.
Goodwin, Dr. W. L.: on "The Analysis of Corundum and Corundum Rock," 180.
Graphite Mining in Ontario, 303.
Gypsum Mining in Nova Scotia, 312.

Halifax Harbour Excursion, 48.
Haulage Plant at Bell Island, 65.
Hinchman, C.: address at Sydney, C.B., 24.
Hudson, J. G.: on Shipping Coal by Wire Rope at Port Morien, C.B., 131.
Hydraulic Mining in B.C., 294.

International Colliery, 28.
Iron and Steel Industries of Nova Scotia, 311.
Iron Bounties, 312.
Iron Mining in Ontario, 301.
Iron Mining in Quebec, 305.
Iron Ore Deposits of Bilbao, 196.
Iron Ore Fields of Ontario, 265.

Jennings, E. P.: on "Leaching Copper Ores by Sulphurous Acid," 123.

Kirkgaard, P.: on "The Treatment of Auriferous Mispickel Ores," 113.

Lay, Douglas: on "The Determination of Lead in Ores by Fire Assay," 224.
Leaching Copper Ores by Sulphurous Acid, 123.
Leaching Auriferous Mispickel at Deloro, Ont., 143.
Lead Mining in B.C., 295.
Lead Mining in Quebec, 308.
Ledoux, Dr. A. R.: on "The Oregon Nickel Deposits," 184.
Legislation concerning Mines in Ontario, 290.
Lewis, Jas. F.: remarks at Sherbrooke, Que., 4; at Sydney, 14.
Libbey, W. L.: remarks at Sydney, 16; Halifax, 49.
Lignite, Production of, in Assiniboia, 299.
Lode Mining in B.C., 294.
Louisburg Excursion, 32.

Luncheons:—
At Glace Bay, 30.
At Sherbrooke, 4.
At Sydney, 13.
At Waverley, 53.

Manitoba, Mining in, during 1900, 299.
Magnetic Iron Sand of the North Shore of the St. Lawrence, 91.
Mason, F. H.: on "Coal, Gas, and Coke as Domestic Fuels, 135.
Meetings and Publications, 289.
Members in South Africa, 289.
Members removed by Death, 288.
Membership of Institute, 287.
Mica, British Markets for, 306.
Mica Imported by Great Britain, 306.
Mica Mining in Quebec, 305.
Miller, Prof. W. G.: on "The Iron Ore Fields of Ontario," 265.
Mineral Production of Canada in 1900, 293.
Mine Surveys, A Simple and Convenient Instrument for, 99.
Mining Machinery, Canadian Trade in, 30.
Mining Machinery Imported into Canada in 1900, 293.

Mining Progress in Canada during 1901, 75–292.
Moxham, A. J.: remarks at Sydney, C.B., 13.
Murray, Hon. George: address at Halifax, 49.

New Brunswick, Mining in 1900, 309.
New Members elected, 21–68.
Nickel Deposits in Oregon, 184.
Nickel Mining in Ontario, 300.
Nova Scotia, Mining in, 1900, 309.
Nova Scotia Steel Co's Output, 1900, 311.
Nova Scotia Steel Works, 34.

Obalski, J.: paper "On the Magnetic Iron Sands of the Lower St. Lawrence," 91.
Officers and Council, 1901, 77–316.
Ontario's Mining Progress, 300.
Ontario's Mining Statistics, 303.
Ore Deposition, 44.

Peacock, F. T.: on "Rope Driven *vs.* Direct Driven Colliery Ventilating Fans," 107.
Pictou County Excursions, 33–35.
Pioneer Work in the Crow's Nest Coal Areas, 230.
Placer Mining in B.C., 294.
Porter, Dr. J. B.: on "Crushing and Sizing at McGill," 205.
President's Medal, 74.
Pyrites Mining in Quebec, 308.

Quebec Excursion, 8–10.
Quebec's Mineral Industries in 1900, 304.
Quebec Mining Statistics, 304.

Raymond, Dr. R. W.: address at Sydney, 14, 17, 26; at Pictou, 37; on "Deep Level Shafts on the Rand, 40; on "Testing Cast Iron," 41; on "Testing Wire Ropes," 43; on "The Deposition of Ores," 44; on "Gold Mining in Nova Scotia," 46; address, Halifax Harbour Excursion, 50.
Reserve Colliery, 28.
Robbins, Frank: on "A Simple and Convenient Instrument for Mine Surveys, 99.
Rope Driven *vs.* Direct Driven Colliery Fans, 107.

Secretary's Report, 287.
Sherbrooke (Que.) Excursion, 4–7.
Shipping Coal by Aerial Wire Rope at Port Morien, C.B., 131.
Silver Mining in B.C., 295.
Stuart, G. W.: on "Gold Mining in Nova Scotia, 44.
Summer Excursions, 289.
Sydney Meeting and Excursions, 15.
Sydney Mines Colliery, 61.

Thetford Mines Excursion, 7.
Treasurer's Report, 69.

Waverley Gold Mines Excursion, 53.
Whiteside, O. E. S.: on "Across the Pitch *vs.* Up the Pitch," 126.
Wire Ropes, Testing, 42.
Wire Rope, Imports in 1900, 315.
Wright, Sydney B.: on "The Treatment of Auriferous Mispickel Ores at Deloro," 143.

Yukon Gold Output in 1900, 295.
Yukon Coal Output in 1900, 296.

MEETINGS.

INTERNATIONAL MEETING.

CAPE BRETON AND NEWFOUNDLAND.

18TH AUGUST TO 5TH SEPTEMBER, 1900.

The American Institute of Mining Engineers having accepted an invitation to visit Canada as the guests of the Institute, a highly successful and thoroughly enjoyable series of meetings and excursions were held under its auspices and direction in Eastern Canada and Newfoundland, in conjunction with the members of the Mining Society of Nova Scotia, commencing Saturday, 18th August.

Among those who participated in these events may be mentioned:—

Dr. James Douglas, New York; Dr. Rossiter W. Raymond and Mrs. Raymond, New York; Mr. Theo. D. Rand, Philadelphia; Mr. J. W. Dougherty, Steeltown, Pa.; Mr. S. M. Pitman, Providence, R. I.; Mr. Walter Hinchman and the Misses Hinchman, Philadelphia; Mr. C. S. Hinchman, Philadelphia; Mr. W. L. Kann and Mrs. Kann, Pittsburg; Mr. and Mrs. A. H. Wethey, Butte, Montana; Mr. and Mrs. F. J. Campbell, Denver, Colorado; Mr. and Mrs. W. Kelly, Vulcan, Mich.; Mr. E. T. Dumble, Houston, Texas; Mr. and Mrs. E. P. Jennings, Salt Lake City, Utah; Mr. C. S. Hill, New York; Prof. George E. Ladd, Rolla, Mo.; Mr. and Mrs. C. H. Tompkins, New York; Mr. and Mrs. H. J. Seaman, Catasaqua, N. Y.; Mr. F. R. Valentine, Woodbridge, N. J.; Mr. A. E. Noble, Anniston, Alabama; Mr. and Mrs. Horace See, New York; Mr. and Mrs. M. A. Valentine, Woodbridge, N. J.; Mr. E. L. Wiles, Wheeling; Mr. and Mrs. Guildford Smith, Buffalo, N. Y.; Mr. and Mrs. W. S. Edwards, New York; Mr. Levi Holbrook, New York; Mr. G. F. and the Misses Baer, Reading, Pa.; Mr. George Iles, New York; Mr. J. B. Cullum, Pittsburg, Pa.; Mr. and Mrs. C. H. Wellman, Cleveland, Ohio; Mr. and Mrs. Sherrerd, Highbridge, N. J.; Mr. J. A. Capp, Schnectady, N. Y.; Mr. J. W. Shook, Birmingham, Ala.; Mr. W. T. Wrightson, Durham, England; Dr. C. H. Jouet, Roselle, N. J.; Mr. A. W. Shaeffer, Pottsville, Pa.; Dr. T. H. Drown, Bethlehem, Pa.; Mr. Walter Wood, Philadelphia, Pa.; Mr. Theo. Dwight, New York; Major R. G. Leckie, Sudbury, Ont.; Mr. Henry S. Poole, Stellarton, N.S.; Prof. W. G. and Miss Miller, Kingston, Ont.; Miss Potter and Mrs. Rorke, Sudbury, Ont.; Mr. James F. Lewis, Sherbrooke, Que.; Mr. George R. Smith, M.L.A., Thetford Mines, Que.; Mr. Charles Fergie, M.E.,

Westville, N.S.; Mr. Graham Fraser, New Glasgow, N.S.; Dr. W. L. Goodwin, Kingston, Ont.; Mr. R. T. Hopper, Montreal; Mr. and Mrs. C. H. Carriere, Levis, Que.; Mr. Hiram Donkin, Glace Bay, C.B.; Mr. J. S. McLennan, Boston; Mr. Mr. and Mrs. W. T. Bonner, Montreal; Mr. R. B. Ross, Montreal; Mr. C. A. Meissner, Sydney; Mr. J. Stevenson Brown, Montreal; Mr. D. M. Sexton, Montreal; Dr. E. Gilpin, jr., Halifax; Mr. R. E. Chambers, Bell Island, Newfoundland; Mr. Wr. W. L. Grammar, Bell Island, Newfoundland; Dr. J. Bonsall Porter, Montreal; Mr. Koehler, Hamilton, Ont.; Mr. and Mrs. B. T. A. Bell, Ottawa; Mr. W. L. Libbey, Northfield, N.S.; Mrs. and Miss Libbey, Brookfield, N.S.; Miss Taylor, New Bedford, Mass.; Miss Batchelder, New Bedford, Mass.; Mr. F. M. Huntress, Halifax; Mr. Charles Archibald, Halifax; Mr. J. P. Edwards, Londonderry; Mr. W. D. Taunton, Halifax; Mr. C. H. Porter, Halifax; Mr. T. R. Gue, Halifax; Mr. A. McNeill, Halifax; Mr. M. McNeill, Halifax; Mr. W. F. McCurdy, Halifax; Mr. George W. Stuart, Truro, N. S.; Mr. W. G. Matheson, New Glasgow; Mr. Harvey Graham, New Glasgow; Mr. James Carruthers, New Glasgow; Mr. George F. McKay, New Glasgow; Mr. Mat. Morrow, Halifax; Mr. C. C. Starr, Halifax; Mr. G. L. Burritt, Halifax, and many others.

AT SHERBROOKE, QUE.

The first social feature in connection with the meeting was the entertainment given by the citizens of Sherbrooke, Que., and the President and officers of the Canadian Rand Drill Company of that city, on Saturday, 18th August. Some forty members of the American Institute of Mining Engineers, with several ladies, arrived by the 6.40 a.m. train on the Boston & Maine Railway, and were joined at this point by quite a number of members of the Canadian Mining Institute, who took the occasion to stop over for the day on their way to join the special train at Levis. An elaborate programme had been prepared for their entertainment. They were met at the railway station by a committee of citizens and conveyed in two special electric cars to the Magog House for breakfast. The Harmony Band was in attendance and played several fine selections during the discussion of the excellent menu provided for the occasion. After breakfast a reception was held by the Acting Mayor and City Council, at which some interesting addresses were delivered.

Mr. J. F. LEWIS, President of the Canadian Rand Drill Company, expressed a few words of cordial welcome to the visitors. He reminded them that not very long ago medals were presented to Canadian veterans throughout the country for keeping certain gentlemen across the line from coming over here. The banner of these Canadian veterans bore the words "No Fenians need apply." On the present occasion the cry was changed. Sherbrooke was captured by ladies and gentlemen from the United States, and was glad to be captured. The citizens of Sherbrooke were glad to see them and to welcome them, and he trusted that they would be delighted with their visit, even though their stay was brief. Mr. Lewis then read the follow-

ing telegram from Mayor Belanger, who was absent on a tour in the Maritime Provinces with the Premier of Canada, Right Hon. Sir Wilfrid Laurier :—

HALIFAX, August 26.

J. F. LEWIS, Sherbrooke :

Exceedingly regret unavoidable absence. Tell our guests I am with you in spirit and welcome them heartily to "Gate of Canada." Annex them, especially the ladies, through much hospitality and kindness.

L. O. BELANGER.

MR. LEWIS also announced that he had sent the following reply to the Mayor :—

"American Institute of Mining Engineers are having a delightful time. All exceedingly regret your absence, especially the ladies."

MR. LEWIS proposed the toast of "The Queen," which was enthusiastically received, the Americans vieing with their Canadian cousins in doing honor to a queenly sovereign and womanly woman.

ACTING-MAYOR LIEUT.-COL. WORTHINGTON, in a few words, further expressed the official welcome. In the name of the citizens he extended the visitors the freedom of the city. "You may annex us for to-day," Col. Worthington said, "but only for to-day." (Laughter and applause.) He hoped that their stay in Sherbrooke would be pleasant, and that they would carry away pleasant recollections of their visit to the metropolis of the Eastern Townships of Canada. (Applause.)

DR. CAMIRAND, President of the Board of Trade, in a few graceful words, welcomed the American visitors in the name of the business men of the city.

GEN. LANG, United States Consul at Sherbrooke, also bade them welcome to that city. It seemed fitting that they should pause on the threshold of Canada to spend a day in this thriving little city, to visit its prosperous industries, to view its natural resources, and to experience its magnificent hospitality, which was never exhausted. He referred eloquently to the cordial good feeling which existed between the government of the United States and the government of Great Britain. (Applause.) Perhaps at this moment the soldiers of the United States and the soldiers of Great Britain were fighting side by side beneath the Stars and Stripes and the Union Jack before the walls of Pekin to rescue their imprisoned countrymen and advance the banner of civilization. God grant them success. Gen. Lang reminded the visitors that they had entered a country as large as their own, extending from the Atlantic to the Pacific, rich in all natural resources, and which awaited foreign capital for development. This should come from the United States, and he hoped his countrymen would take advantage of the opportunities offered. (Applause.)

DR. JAMES DOUGLAS, President of the American Institute of Mining Engineers, and a former resident of Quebec, replied on behalf of the visitors to the welcome they had received. The cordial reception was appreciated, and they anticipated

a pleasant day in Sherbrooke. He referred to the Capelton Copper Mines, and reviewed their history. As mining engineers they would have been glad to visit these mines, but time would not permit it on this trip. In conclusion, Dr. Douglas desired the citizens of Sherbrooke to acoept the hearty thanks of his party for the greeting given them. (Applause.)

The party then began its tour of the city, visiting various industries and other points of interest in the following order: Dominion Carpet Company, Victoria Park, Jenckes Machine Company, Electric Light Station, the Paton Mills, and the Canadian Rand Drill Company's works. They were most cordially received at each place. While the gentlemen were visiting the Jenckes Machine Company's works, the Electric Light Station, and the Paton Mills, the ladies were given a carriage drive through the city under the escort of Lieut.-Col. King.

After winding up at the Canadian Rand Drill Company's works, the party was entertained at luncheon through the courtesy of Mr. J. F. Lewis, the President of the Company, the 53rd Battalion Band being in attendance.

After luncheon, DR. JAMES DOUGLAS, President of the American Institute of Mining Engineers, said that Dr. Raymond would return thanks more eloquently than he could, and would likewise perhaps be able to explain the paradox that he, a Canadian by birth, was representing the American Institute of Mining Engineers, while a thorough going Yankee was representing the Canadian Mining Institute. Sometimes the Canadians resented the assumption of the term American as representing Americans south of the line. However, as in this case, they had in their host an American who might be supposed to represent the peoples on opposite sides, and this would perhaps explain the paradox, and until some more euphonious term than United Staters should be invented there was a good reason why the Americans should assume the more convenient term American.

DR. R. W. RAYMOND, Secretary of the American Institute of Mining Engineers, referring to Dr. Douglas's remark about his being a Canadian representing the Americans, and Mr. Lewis being an American representing the Canadians, pointed out that from the beginning the American Institute of Mining Engineers had always had members who were citizens of Canada. They had had presidents from Canada and vice-presidents from Canada, and they felt themselves just as much Canadians as they were Americans.

MR. LEWIS said he wished to call upon a gentleman, who although the rector of St. Peter's Church, Sherbrooke, was at present engaged in what might be called mining work.

REV. DR. DUMBELL, in a happy speech, remarked that he felt a little out of place in being asked to speak at a mining re-union. The Chairman's allusion was probably because he was at the present time having the rock taken out in order to get a foundation for the new church they were about building, and he humorously

CREMATO
Canadian and American Institutes of Mining Engineers 27th Aug. 1903
Halifax N.S.
Notman Studio 7810

added that he was finding the rock which was being taken out as firm and as hard as he had ever preached it. Dr. Dumbell also alluded to the pleasant feeling now existing between the people of the United States, where he had lived for so many years, and the people of the Dominion of Canada, and to the fact that at present in China the American and the British troops were at this moment fighting together for the preservation of life and the cause of Christianity.

The American visitors were delighted with the hospitality accorded them, and one and all were profuse in their expressions of gratitude for the entertainment provided for them, and were especially grateful to Mr. Lewis for his untiring efforts to this end.

AT THETFORD ASBESTOS MINES.

At three o'clock the party left on a special Quebec Central Railway train, kindly placed at their disposal by Mr. Frank Gundry, general manager, and Mr. J. H. Walsh, general freight and passenger agent, for the asbestos mining region of Thetford and Black Lake. At five o'clock they were received at Thetford by Mr. George R. Smith, M.L.A., manager of the Bell's Asbestos Company, Limited; Mr. Andrew Johnson, of the Johnson's Company; Mr. R. T. Hopper, Montreal, and Mr. B. Bennett, of the King Bros. Asbestos Company, and were taken over the different mines, after which the party were entertained at supper at the Thetford Club. The whole town was in gala attire, the various private buildings being handsomely decorated with flags and bunting, and the St. Jean Baptiste Society, with their band, were also present to assist in welcoming the distinguished visitors.

The method of mining and treating the asbestos bearing rock of the Eastern Townships has been described already in the *Transactions*, but the following notes on the work being carried on by this Company may be of interest :—

The mining is carried on in open quarries, what is known as the big pit at Bell's mine being several acres in area and about 150 feet deep. The serpentine is drilled and blasted and is conveyed to the surface by cableways and derricks. The first task is the separation of the asbestos-bearing rock from the barren rock, and this is done by hand-picking. The portions containing asbestos are then conveyed to the cobbing house, where old men and boys knock off the long-fibered asbestos from the serpentine. Generally, cobbing is limited to veins from ¾-inch thick upward, the separation of the asbestos carried by the thinner veins being done mechanically.

The mechanical separating process is a simple one. From the cobbing room the rock is deposited in chutes leading to a battery of rock breakers below. At Bell's mines gyratory breakers of the Gates' type are employed, and from them the coarser fragments pass to a set of crushing rolls. From these rolls the crushed rock passes on to travelling belt picking tables, where boys standing alongside pick the fragments of barren rock off the belt and throw them to one side. The mineral bearing fragments pass from the picking tables to cyclone pulverizers in which the

final crushing is performed and where a current of air separates the light asbestos fibre from the heavier rock dust. At various points between these crushing and picking operations the material is screened, and finally the asbestos fiber is screened from the fine dust and finely broken fiber. The operation is a continuous one, the rock passing from the top floor downward through the various processes until the final product—commercial asbestos—is turned out at the ground floor. Except for the work of the boys at the picking tables the operation is a mechanical one throughout.

The separated asbestos is divided into three grades for the market. The first grade comprises the long-fibered material which is separated by cobbing. The two other grades are similarly determined according to length of fiber, color and freedom from foreign matter. The material not good enough to be included in any of the three commercial grades, but which contains fiber, is called "waste" and really constitutes a fourth grade. The sorted asbestos is packed in bags of 100 lbs. capacity for the market. At the Thetford mines about two tons of commercial asbestos is obtained from every 100 tons of rock which is crushed. Altogether about 600 men are employed in the mining operations of the three companies working the deposits at Thetford.

At the conclusion of their hasty round of the mines and works, the members of the party were assembled to partake of the excellent dinner provided by their hosts of Thetford. Previous to speeding them on the remainder of their day's journey to Quebec, Mr. George R. Smith, M. L. A., manager of Bell's Asbestos Company, acting as the representative of the three companies, welcomed the guests in a neat speech, encouraging their exertions to dispose of the good things which heaped the tables before them.

WELCOMED AT QUEBEC.

From dinner the party proceeded to the train, which landed the company, tired but enthusiastic, in Quebec at 11 o'clock. Here were found the western members of the Institute and the Canadian party who had previously arrived, and who had provided an English supper of sandwiches and ale in the grill room of the Chateau Frontenac, where a number of the city's officials and the Quebec Minister of Colonization and Mines welcomed the American guests with brief addresses.

HON. A. TURGEON, Commissioner of Colonisation and Mines for the province, said that it afforded him the very greatest pleasure—as he had been requested by the Premier and the Provincial Cabinet, as well as by his colleague, Mayor Parent, who was unavoidably absent from the city—to extend to them the fullest welcome and hospitality to the City of Quebec. He drew a graphic word picture of the beauties of the ancient capital, so rich in historical data, and where the great Wolfe and Montcalm had fallen, and where one of their own generals (Gen. Montgomery) unfortunately lost his life. He went on to say that he hoped the visit of the

Party of Canadian and American Mining Engineers, taken on the site of the old fortifications at Louisburg, Cape Breton, during Excursion of The Canadian Mining Institute, August, 1900.

members of the American Institute of Mining Engineers through such centres as Sherbrooke, Thetford, and along the Quebec Central Railway, would be the means of giving a fresh impetus to the development of the plenteous resources of this grand old province, in her mines, her pulp, her water powers, etc. With the necessary capital and energy these resources could not fail to become sources of inexhaustible wealth. In conclusion, he expressed the hope that they would be greatly interested in the historic city. (Applause.)

Dr. JAMES DOUGLAS, President of the American Institute of Mining Engineers, in acknowledging the cordial welcome extended by the Hon. Minister, said that the tables ought to be reversed, and that he should be the reception committee. "My recollection of Quebec," he went on to say, "goes back to the forties, when the Chateau St. Louis stood upon the site of the beautiful Chateau Frontenac of to-day ; when the old riding school, which is now nearly all cremated, stood on the glacis nearby ; when there were no water works in the town, and the water carts were taken down to the river where the market place now stands, and being filled from the plenteous St. Lawrence were carted to the upper town and the water poured into tanks for distribution through water valves, etc., to our houses ; when the town was only illuminated by coal oil lamps ; even before steam ferries crossed the river, and when they were carried from side to side by horse boats ; when wealthy people lived in St. Paul Street ; when the first east wind brought up a fleet like a flock of winged birds and so completely covered the river, without any berth between St. Charles and Cap Rouge, and when 100 to 200 large wooden ships were built during the winter and launched the following spring. My experience likewise extends back to the early days of gold mining on the Chaudiere. I had always regretted that hydraulic methods were not applied to the placers of the Chaudiere, as I am satisfied that some of them could be remuneratively handled in that way. I had had bitter experiences of the copper mines of the province ; but at the same time I thought that though the ore was very lean, with railroads and proper appliances those low grade ores might possibly be made to pay, and if they could there were immense resources within the Province of Quebec ; that if the deposits of ilmenite, such as those of Baie St. Paul, could be utilized the province contains some of the very largest deposits of iron ore in the world. With these minerals known to exist, it opened up great mining possibilities for the province, and I thought that it must be probable, with the Laurentian range to the north with its boundless area of crystallized rocks and the Notre Dame range to the south, the extension of the Appalachian chain must contain immense mineral wealth, but that covered as the ground is for six months in the year by snow and at all times by a heavy growth of timber, prospecting and exploration would necessarily be slow, and that therefore the very rapid progress made by the mining industry of the extreme west could not be expected in the Province of Quebec. (Applause.)

Dr. R. W. RAYMOND, Secretary of the American Institute, added that while their president (Dr. Douglas) seemed to be at home in Quebec, this was his very first visit to the ancient capital, and his presence there at this time was the fulfilment of a dream of many years. They did not require the imagery of the past to realize that Quebec was full of historic interest; they could still see it on every hand. He only regretted that he could not stay longer, but every moment of his visit would be filled with delight. (Applause.)

On Sunday morning at ten o'clock, the Quebec Light and Power Company placed two electric cars at the disposal of the party, and they were driven around the city and landed at the Citadel. From here they came down the new Dufferin Terrace extension, and the whole party, especially the ladies, were in ecstacies over the delightful views of the city and the noble river flowing placidly by beneath.

In the afternoon, through the courtesy of the Hon. the Minister of Marine and Fisheries, the government steamer "Druid," with Commodore J. U. Gregory on board, was placed at the disposal of the reception committee, and with the Royal Artillery band to discourse sweet music, the visitors were taken up the harbor as far as Sillery and the site of the proposed new bridge. They were then entertained by the Hon. R. R. Dobell at his beautiful residence "Beauvoir." Having returned to the steamer, they proceeded down the river as far as the Island of Orleans, and enjoyed a view of the Montmorency Falls, the Graving Dock at Levis, and the extensive establishment of Carrier, Laine & Co. Just before disembarking at the wharf, Dr. Douglas, in a happy vein, proposed a hearty vote of thanks to the Minister of Marine and Fisheries and to Commodore Gregory, which was received with three cheers and a tiger.

At nine o'clock in the evening, a special train comprising five Pullman sleepers, dining and baggage car was boarded at Levis for Sydney, Cape Breton, the ultimate destination of the party. During Monday the train traversed the beautiful Metapedia Valley, the great salmon and trout fishing region, and along the Baie de Chaleur, where the Gaspe Peninsula stands out boldly and impressively. Port Mulgrave, on the Strait of Canso, was reached on Monday evening, and the train was held here until daybreak on Tuesday morning, when the cars were ferried across to Point Tupper, and the journey continued to Sydney, which was reached shortly before noon.

AT SYDNEY, CAPE BRETON—THE STEEL WORKS.

Immediately upon arrival at Sydney, the visitors were met by the local committee, headed by Mayor Crowe and the officers of the Dominion Iron and Steel Company, and were at once started on a tour of inspection of these immense works now under construction, and the progress that has been made within one year is simply marvellous. In fact, with the exception of a few who were aware of the facts it was difficult to realize that so much had been accomplished within the short space of twelve months. The result has been that to-day the population of Sydney is over 12,000, and is going up by leaps and bounds.

The work of the Dominion Iron and Steel Company, of which Mr. Henry M. Whitney, of Boston, Mass., is the President and leading spirit, contemplates not only the erection of a modern steel plant at Sydney, but the manufacture of coke from the coal mines of the Dominion Coal Co., the mining of iron ore at Belle Isle, Newfoundland, 400 miles by water from Sydney, and the opening of limestone quarries at Georges River, Cape Breton. The new coke plant of the Dominion Iron and Steel Company will consist when completed of eight batteries, each containing 50 Otto-Hoffman by-product coke ovens, or, altogether, of 400 ovens, the total capacity of which will be 1,600 tons of coke per day. The gas from these ovens will be utilised in the company's open-hearth furnaces, while the other by-products, ammonia and coal tar, will be marketed. The plant is substantially a duplicate of the coke plant of the New England Gas and Coke Co., built by Mr. Whitney at Everett, a suburb of Boston, Mass., which has been in operation for some months, using the same Cape Breton coal for the raw material which will be used at the Sydney plant. As proof of the certain success of coke making from its Cape Breton high sulphur coals, the new company points to the success of the Everett plant, and to the fact that the Nova Scotia Steel Co. has used coke made from the same coal in its Ferrona furnaces for a number of years. In this connection it will be interesting to quote from some recent analyses of washed coal slack from the Cape Breton mines and of the coke made therefrom by the Nova Scotia Steel Co. :—

	Washed Coal		Coke	
	Ash.	Sulph.	Ash.	Sulph.
Hub	4.37	2.38	11.2	1.34
Phalen	7.05	2.87	11.3	2.13
Harbor	5.5	3.12	12.8	2.79

Regarding the expectations of the company in the shape of profitable by-products from its coke ovens, no better illustration can be presented perhaps than the following brief quotation from a pamphlet which it has widely distributed in Canada.

"At Everett the New England Gas and Coke Co. sell their sulphate of ammonia at 2½ cts. per lb., and get about 30 lbs. from a ton of Cape Breton coal in the process of coking. Assuming that only 28 lbs. of sulphate of ammonia will be obtained at Sydney, and that the selling price will be only 1¾ cts. instead of 2½ cts. per lb., it will yield 49 cts. per ton of coal. The by-product ovens at Everett also obtain from a ton of Cape Breton coal about 12½ gallons of tar, which is sold at 2 cts. per gallon, and about 5,000 cubic ft. of gas, which is sold at 20 cts. per thousand. At Sydney the surplus gas will be used in the steel mill, and it will be fair to estimate its value at the cost of natural gas in the most prolific natural gas districts of the United States, or 5 cts. per 1,000 ft. This will give the steel mill as cheap fuel as if it were located in a natural gas district. It is calculated that the quantity of gas produced at Sydney will be somewhat less than at Everett, as the coke will be treated somewhat differently to suit the blast furnaces, but it will not be less than 3,000 ft.,

which at 5 cts. per 1,000 ft. will be 15 cts. per ton of coal. The quantity of tar obtained will be about 10 gallons per ton of coal, which at 1 ct. per gallon, half the price obtained in Boston, would give 10 cts. per ton of coal. Thus the value of the ammonia, gas and tar obtained from each ton of coal will be not less than 74 cts., while the cost of manufacturing the coke and by-products will only be about 10 cts."

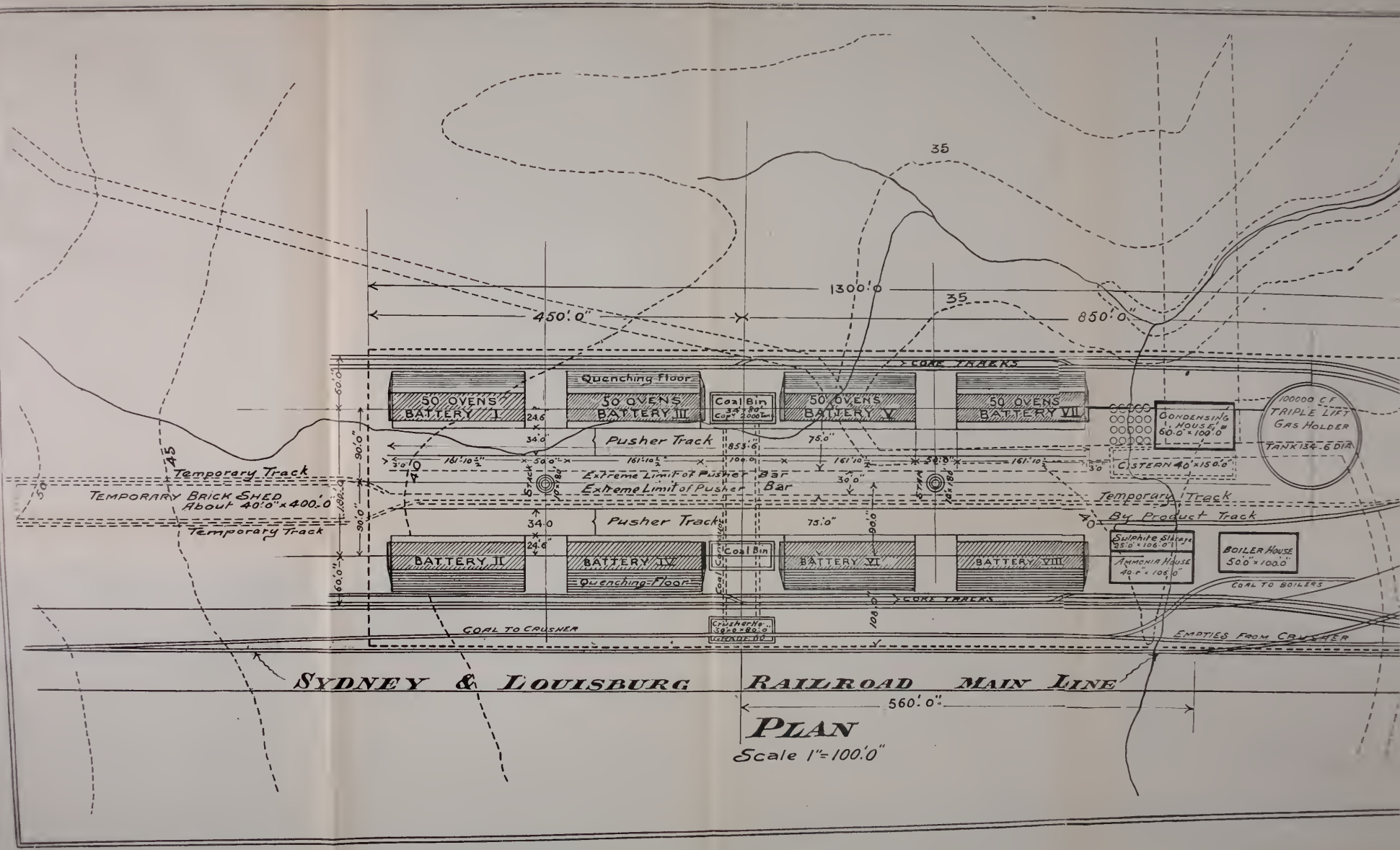
These estimates, if they prove reliable, certainly present very favorable figures. The construction and operation of the Otto-Hoffman coke ovens are pretty well known, and need not be described here. At the time the visit to the plant was made the several batteries of ovens were in various stages of construction, some of them being practically completed and others only just begun. The construction, as far as could be seen, bore every evidence of excellent workmanship and materials. The contract price of the plant is not known, but the preliminary estimates of the company placed it at $1,250,000, or a little over $3,100 per oven, which is certainly a low figure.

Steel Plant.—The site of the steel plant is directly on Sydney Harbor and comprises 460 acres of land and some 346 acres of water. In a future issue we hope to give complete details of the plant and its equipment so that here only its more general features will be mentioned. Briefly summarized the plant will comprise blast furnaces and open-hearth furnaces having a capacity of 1,400 tons of steel per day, blooming mills, general machine shop and foundry, unloading piers and wharfs, and all necessary subsidiary buildings. The only part of the plant now completed and in operation is the machine shop and foundry, which is 60 x 480 feet in plan. The blast furnace plant, consisting of four 350-ton furnaces, is next furthest advanced; indeed, the company expresses the hope of putting one of the furnaces in blast early this fall. The other main buildings had not advanced beyond the foundation work in any case. It may be noted in passing that this foundation work has been of a very heavy character and that concrete has been used almost exclusively.

Practically all of the construction materials and machinery have been imported from the United States, almost none of it being obtainable in the Province. Skilled labor has also come from the States, and the ordinary laborers are for the most part inhabitants of Newfoundland. The contractors for the blast furnaces are Riter & Conley, of Pittsburg, Pa., and the blowing engines are to be furnished by the Edw. P. Allis Works, of Milwaukee. The fire-brick and cement used are also imported, but much of the general structural work is being furnished by the Dominion Bridge Company.

In addition to the steel making plant proper, the works when completed will comprise extensive railway yards, water-supply and drainage systems, electric lighting system, boarding and lodging houses for employés, hospitals, offices, storage houses, yards, etc. The water supply will come from Sydney River about five miles from the works, where a dam is being constructed, and will amount to 3,000,000 gallons per day. About eight miles of mains will be included in the distribution

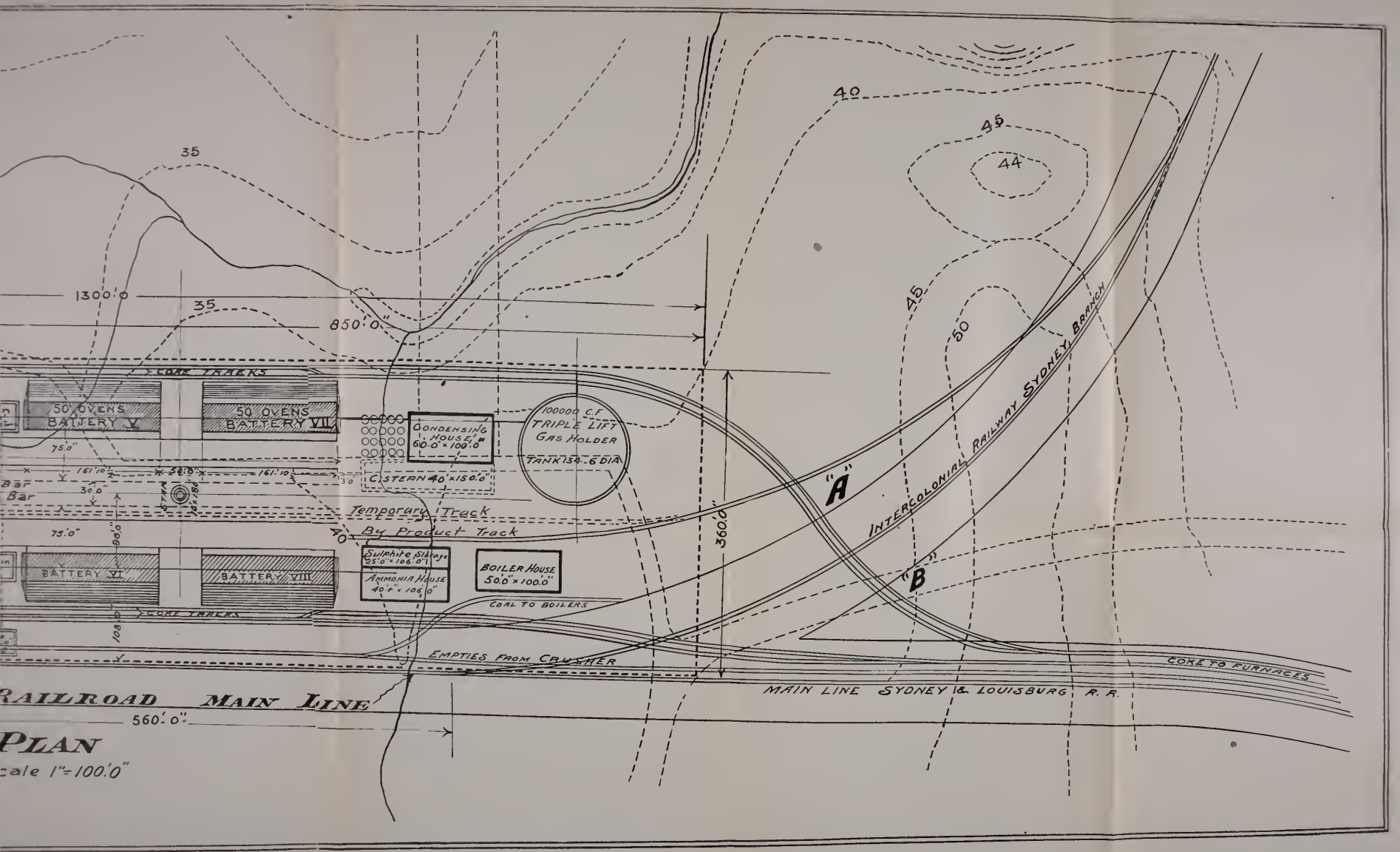
PLAN OF COKING PLANT OF THE DOMINION IRON & STEEL CO., Limited, UNDER CONSTRUCTION AT SYD



PLAN

Scale 1"=100'0"

OF THE DOMINION IRON & STEEL CO., Limited, UNDER CONSTRUCTION AT SYDNEY, CAPE BRETON.



system. The general layout of the works is along a comparatively narrow area of ground about two miles long, following the harbor front. At one end are the shipping piers, followed by the blast furnace plant, open-hearth furnances, blooming mill, machine shop and coke plant. Nearly 20 miles of railway track will be required to connect the various parts of the plant and yards.

The manager of the Dominion Iron and Steel Company, of which Mr. Henry M. Whitney is President, is Mr. A. J. Moxham, Assoc. M. Soc. C. E., who will be remembered as having been President of the Lorain Steel Co., of Lorain, O., previous to its absorption by the Federal Steel Co., and also as having been associated for many years with Mr. Tom L. Johnson in the Johnson Co., with extensive works at Johnstown, Pa., for the manufacture of street railway rails, switches and track supplies.

LUNCHEON AT THE STEEL WORKS.

At noon the visitors, who had spent an interesting morning going over the new plant in course of construction, were entertained to luncheon in the spacious dining hall recently erected for its employees by the Dominion Iron and Steel Company. After luncheon had been served :—

Mr. A. J. MOXHAM said : —Gentlemen of the American Institute of Mining Engineers, the Canadian Mining Institute and of the Mining Society of Nova Scotia, if you were not mining engineers I would commence with a few words of apology for the meagre hospitality that we have been permitted to extend to you, but as you all know with all industrial matters and in all new countries the first difficulties in regard to the inner man are always great. We here have had to think a great deal more of sand and cement and stone than we have had of ourselves. But while we cannot do very much in that line, we will try and make it up by extending to you the very heartiest of welcomes, and give you many, many thanks and ask you to forget a few of our little home trials. To you one and all we extend the very heartiest and warmest of welcomes. (Applause.)

Dr. JAMES DOUGLAS :—Mr. Moxham, we desire—at least I and the Institute which I represent do—to thank you personally for the greeting you have extended to us and the substantial way in which you have expressed it. If it were merely to thank you for this lunch, we would use one of the stereotyped phrases used to return thanks, but it would be improper to stop short at that. I think that we see here around us and realize more than any of us ever dreamed of, whether we belong to the American Institute of Mining Engineers—who recollect are Americans and not United Staters—or whether we belong to the Canadian Institute of Mining Engineers or to the Mining Society of Nova Scotia. We have all had dreams in the past, and we believe really and not merely dream, I trust, that we have good substantial grounds for believing in the great possibilities of the mining and metallurgical advancement of the Dominion, and here for the first time we see something I wont say approaching the realization of our dreams, but far exceeding it. Any one who

has ever attempted heretofore in Canada to develop these iron industries have been more or less proceeding on false grounds. Of course, we remember that old attempt of the forges at Three Rivers utilized in the old French times, and since that the vacillating success on bog iron ores. In my recollection two notable attempts have been made to make some use of the iron ores of the Dominion. Both of them began at the wrong end. One was down at the Moisie, which was operated by Mr. Markland Molson ; the other was at Londonderry, where instead of following the old lines they began to make steel direct by an untried method simply because it carried the name of Siemens with it. At Londonderry I believe they were wrecked upon Siemens' direct process. But here we find capital from across the line coming into this wilderness and erecting furnaces which from first to last has as its object the manufacture of coke and the saving of its bi-products, or to the end the manufacture of steel upon methods and processes well tried and well tested and of the most advanced and improved description. I think, therefore, as I said, that it would be altogether improper to confine our thanks to the Dominion Iron and Steel Company simply for the good things they have spread before us without extending our thanks to them for the far higher and more magnificent reason that these gentlemen have come here from the ends of the earth, and are erecting works, which will be a model not only for Canada but for the whole world. I ask you to join with me in returning thanks not only for these immense mining works but to the Dominion Iron and Steel Company. (Applause.)

MR. CHARLES FERGIE :—On behalf of the Canadian Mining Institute, I beg to thank you for the kind manner in which you have received us to-day and for the opportunity you have afforded us of going over these extensive and interesting works. I can only say that I wish you every success and prosperity.

MR. J. F. LEWIS :—I wish to add one word in endorsing what Dr. Douglas said regarding the establishment of such works as this for the benefit of Canada. When we started from Quebec I thought we were going to visit Cape Breton, but since I have arrived here I have made up my mind that we are visiting New America. We see evidences of the great progress that has been made towards building this wonderful establishment of steel-making and of all kinds of coke-making, and it seems to me, and I said to myself that this is surely an answer to prayer, because for the ten years that I have been doing business in Canada I have been praying for just such works as these. It is just what Canada needs, and I wish to say to you all that there has nothing been done towards forwarding the growth and extension of Canada that will at all equal these works.

DR. R. W. RAYMOND :—Of course, Mr. Chairman, I can easily appreciate Mr. Lewis' sudden piety when he finds what has been done in a wilderness in erecting the very works the Rand machine shops in Sherbrooke needed. But I have no doubt there is piety at the bottom of it. I do not believe that this great iron industry could be established as a mere pleasure. There must be duty in connection with i

even in the form of a tariff (applause). I can remember when I came up here nearly a dozen years ago. I came up to examine the iron resources, but unfortunately the utilisation of the Newfoundland ore did not occur to me, and I reported that there was a great deal of quiet and a great deal of piety and not much iron ore. I am sure that every one of us feels the progress that is being exhibited here as apart from our own progress. What we see here is a part of our own instruction and a part of our own triumph. I find gentlemen who are executing all the vast plans members of the American Institute of Mining Engineers on the other side of the line—if there is anyone who knows where the line is : I do not—and I have not had anything foreign happen to me except when the porter asked me for the key of my trunk. I have been considerably amused at my friend, Dr. Douglas, who was born in Canada, posing as an American from the United States, and my friend, Mr. James Lewis, who was born in the United States, posing as the most loyal of Canadians, and if you come to that, our own Institute, which belongs everywhere on the Continent, pretending to go around as if it were visiting strange places and be received by itself and thank itself for the entertainment which it gives itself. This is what makes the perfect harmony, as if a man meets a man who is, as Horace says "*animae dimidaum meae*" (the other half of his soul) the two are in such perfect harmony that both his thanks and the entertainment becomes a soliloquy. We are the most magnificent hosts and the most cordial guests of whom history gives any knowledge. (Laughter.)

SHIPPING PIERS OF THE DOMINION COAL CO.

Luncheon over the members were taken over to the new furnace plant and the site of the new docks, the whole presenting a scene of great activity. Thereafter a visit was paid to the great International shipping piers of the Dominion Coal Company.

Pier No. 1—900 feet beyond high water mark, stands 27′ 0″ above high water mark, double track, empties returned to yard by radial table, and return track laid between two outside tracks, which are used for shipping. Coal shipped direct from car to chutes to hold of vessel, and also by Ludlow towers and buckets ; capacity 10,000 tons in 24 hours.

Pier No. 2.—650 feet beyond high water mark, stands 37′ 10″ above high water mark, double track, shipping carried on by chutes from cars to vessel's hold. Empties run by gravitation to drop-table at end of pier, which works automatically, dropping cars to low level track, which is laid directly below upper tracks, whence the cars run by gravitation to assembly yard, capacity 10,000 tons in 24 hours. Built of South Carolina yellow pine, on creosoted piles, and protected by creosoted cribs at intervals of 100 feet. Built in 1898.

MEETING IN THE ROSSLYN RINK.

About two hundred mining engineers and others interested in mining assembled in the Rosslyn Rink, Sydney, where a meeting had been convened under the auspices of the Canadian Mining Institute. In the absence of Mr. Fowler, President, Mr.

Charles Fergie, M.E., Senior Vice-president, was called to the chair. Mr. Fergie called upon His Worship Mayor Crowe to extend a welcome to the visitors on behalf of the Town of Sydney.

MAYOR CROWE:—Mr. Chairman, and gentlemen of the Canadian Mining Institute, as well as of the American Institute of Mining Engineers and the Mining Society of Nova Scotia, I suppose it is fitting that I, as chief magistrate of this town, should bid you a very hearty welcome not only to Sydney, but I hope I may say to the Island of Cape Breton. I have no very extended remarks to make, but I would like to say that the citizens of Sydney and of the Island of Cape Breton are pecu liarly interested in having a visit from such a distinguished body of men as compose the American Institute of Mining Engineers. We pride ourselves that we have in Cape Breton a large body of mineral wealth, to some extent developed and being more and more developed rapidly each year. We know your visit this year has been particularly occasioned by a desire to see the work of the Dominion Coal Company and of the Dominion Iron and Steel Company, now under construction. If we have a regret at all it is that your visit should occur this year, when things are somewhat askew owing to the rapid growth of the town, and we cannot entertain you in the way that we would desire, but we trust that what you have seen to-day, and what you will see to-morrow and on Thursday, will induce you to return at some future time. We hope it is not too much to ask a visit in the very near future; we will give you the same welcome as to-day, and we will entertain you in a more becoming manner. I have not much to add except to say that the citizens of Sydney cordially greet you, and we regret that we are not able to put at your disposal the entertainment that you deserve. We have, with the assistance of the Steel Company, arranged for a trip through the Bras d'Or lakes, and we trust that you will have good weather, and that you will enjoy the charming scenery of a vast inland lake of salt water practically non-tidal, and which is attracting tourists year after year. Let me conclude by again saying that the citizens of Sydney rejoice to see these different societies here, and trust that the time is not far distant when you will return to us. (Applause.)

MR. W. L. LIBBEY—Mr. Fergie welcomed you on behalf of the Canadian Mining Institute, and I am very glad on behalf of the Mining Society of Nova Scotia to extend you a hearty welcome to our province. You are here to-day, particularly the American members, to see a little of an almost unknown land to you, to a great many of you at least. That was particularly brought to my mind to-day by the remark of one member who was not in my own line of mining, but who said he did not know that Nova Scotia ever turned out any gold. Well, now I think that within a very few years all of you will know that it does turn out gold, and also that it is capable of turning out a vast amount of iron. We are only too glad that you are here to get a practical object lesson in what it can produce. Its possibilities to my mind a not yet known. The buildings being put up here by the Iron and Steel Compan

are a most practical object lesson, but it is not touched yet. We hope that what you see will cause you to give this province a great big advertisement. I am not a native born Nova Scotian, but the welcome which the Mayor has extended to you must assure you of the hospitality of the people. I can only do my own part as an individual operator and as a member of the local mining society. Gentlemen, you are welcome. (Applause.)

DR. JAMES DOUGLAS—It would be superfluous, gentlemen, to say that we heartily accept the welcome that is given us, and that as far as lies in our power we will do our best to make you an adequate return. We are not in the financial world, and whether, as our kind friend who preceded me intimated, it will take the return of dollars and cents remains to be seen, but that it does take the shape of hearty thanks and that it will take the shape of some little reform is extremely likely. I quite agree with him that what we have seen to-day is simply a forecast of what I believe will be seen in the future. I passed through Sydney some three years ago. I went out to see the developments of the Eastern Development Company, which as yet do not seem to have materialized, and that was the only large metallurgical interest in this neighborhood. To imagine that in that short period should have grown up such a magnificent enterprise as we have seen to-day would seem to be without parallel. At that time Bell Island had only been discovered, but little of the ore had been stripped, and its possibilities were not appreciated. The fact that these gentlemen have within that short period actually exposed what they feel confident is over 100,000,000 tons of iron ore within economical and accessible distance of their works, gives us a faint forecast of what lies before the Dominion of Canada. We hardly appreciate the amount of undeveloped territory upon this continent. I am rather inclined to think that if we took the map of North America and the map of Africa we would find that there is probably more undeveloped territory on the continent of America than there is unexplored territory on the continent of Africa. The statement seems perhaps startling at first sight, but look at Labrador. There are thousands and thousands of square miles on which the foot of white man has never trod. Take the great Northwest, which has just been touched by exploration in the Klondike. Its resources in copper are now for the first time about to be superficially observed by the Geological Survey of Canada. They have sent out this year to the Great Copper river, where all the vague reports indicate that there are vast copper resources. The Hudson's Bay is always open for a certain period of the year—not quite as long as Lake Superior, but to within two months of it—ergo, a short line of railway of two or three hundred miles will bring these copper resources to a point where they could be handled. And then there is Keweenaw Point, which is a well known copper mine jutting out of the south shore of Lake Superior, between the Wisconsin line and the eastern half of the lake. I merely mention this as one of the remaining possibilities that lie in the great Northwest and the great North American continent. Rocks of nearly every age exist there. In our immediate neighborhood

we know that its crystalized rocks are all ore bearing, and the result of the mere superficial and extremely insignificant exploration that has heretofore been made, make it almost certain that the resources of this great northern section of the continent will produce the more useful if not the more precious treasures that are being extracted from the chief central and southern zones. Canada has, therefore, a great future before it. It lies in the province of every miner and every metallurgist to develop these resources of America, as we are all Americans, but it rests more especially of course upon the miners and metallurgists to do so. Heretofore they have not shown that intense energy which the stimulus of success I believe will give them in the future. To-day one reason given for that was that so many of us drift away from the Dominion to the neighboring States. Why do they drift away? I am afraid it is because the inducements at home were not strong enough to keep us here. But I think all that is changing and rapidly changing, and that in the future the young men of Canada will remain at home to develop Canada's resources, and there is an augury for the future from the fact that the education which is being given by the mining schools, at McGill University, Montreal, at Queen's College, Kingston, and elsewhere, is going to admirably fit them for their life's work. Therefore, I, as a Canadian, sincerely thank you for the hearty welcome which you have given the American Institute of Mining Engineers, and wish your two societies God speed in the work that you have in hand, and hope that the most unbounded prosperity will be the lot of Canada and your own. (Applause.)

DR. R. W. RAYMOND: Since I entered the Dominion upon this visit, Mr. President and gentlemen, I must confess that the thought that has been impressed upon my mind was somewhat different from the anxieties which seem to appertain to the mind of my Canadian friend, Dr. Douglas. I am a little worried as to how we are going to keep the American Engineers in the United States. I did not know that the doctor was hankering for the copper of the Northwest, and I am a little afraid that 99 John street may know him no more, and that I will no longer be able to find me near my brother. (Laughter.) I know that we have lost a good many smart men whom we could not afford to spare, such as a Libbey and a Lewis. But after all I do not see that it makes any difference. I could not see any foreign aspect. Wherever we go on this continent we are face to face with foreign forms, and even there I managed to find myself very much at home and to see in the face of all the people I meet an American type which seemed stronger than any type of local blood. I must confess that the very sudden development of this part of Nova Scotia had taken me very much by surprise. I evidently was not a prophet or the son of a prophet when I came hear a dozen years ago. I was not wise enough to take stock in the Dominion Coal Company, and I even pitied my friend, Mr. McLennan, who seemed to be entangled in a coal undertaking up here. I do not pity him any longer, but rather feel envy. (Applause.) However, I feel that looking back upon the past we may fairly say that all our great developments anywhere in this western world have been

similarly sudden. I do not know whether we are mining engineers enough to know where the next boom is going to be and to get in in time. I know an instance of where a man could have bought a property for $10,000, but he cannot get it for $50,000,000 now. Therefore, when we undertake to make a rule of prophecy out of it we are not able to look at one and the same time into the earth and into the future. If we forget the earth we study the future, and if we forget the future we study the earth. After all I think our functions will continue to be that as in all the centuries to let accident and the wisdom of others, rather than ourselves, direct the course of Empire and of progress, and we will come in to make that progress stable and permanent. Our vocation is not to look into barren land and recommend it for investment, or to make prognostications about what it will yield before it has ever been opened. (Hear, hear.) Every mining engineer knows how disagreeable that part of his business is; and the men who go out into the wilds and build stamp mills and travel over the horrible roads of a new country, the men who look out in advance and execute step by step such vast enterprises as you see here to-day, are not worrying themselves in writing prospective criticism ; we leave it to the newspapers to insult us, or admire us, or to call us down if they choose, but we simply bother ourselves in trying to do the thing and when the thing is done it speaks for itself. (Applause.) As long as we continue to be the men who do the things we shall continue to be a lot of good fellows, because the man who does the thing leaves him hours of recreation with his fellows, is most interesting in conversation, most hearty in his welcome, most retentive in his memory of welcome. For instance, I have been connected with the American Institute since 1871 ; it then had thirteen members, but it now has three thousand. If you come to any meeting of that Society and think that by sitting down in a hall and hearing some papers read you have struck the heart of that society you make a huge mistake. It is on the train, in the wagon, at the hotel over the evening pipe—I am afraid sometimes it is over the evening hot Scotch—(Hear, hear) that you, will find the real work of that Institute going on. We learn more in our interchange of reciprocal feelings, we teach more in our talks, in our clasping of hands, in our social intercourse, than we do in the printed page. (Applause.) In other words, the American Institute might just as well turn itself into a big publishing house and start a newspaper. The Institute of which I am the secretary will get out its transactions and see that you get big value for your money, and the material for the next big volume is already at hand. It is not a question of piling up statistics as a permanent record, but it is a question of welding these people who do things into a social, harmonious and organized institution. Our institution was the first on this continent to do that on a large scale, and these societies of ours have welded together a great profession and made it a great factor for happiness and prosperity and knowledge among men. That is why I like to hold meetings anywhere. (Applause.)

Mr FERGIE—More especially referring to the mining societies, I would like

to take this opportunity while here in Sydney of reminding all those engineers, both in iron and coal, who are not now connected with any society the great advantage of joining. We have in Canada two prosperous societies—the Canadian Mining Institute and the Mining Society of Nova Scotia—and I would give all a very welcome request to send in their application for membership which will be duly considered.

Mr. B. T. A. BELL—Mr. Chairman and gentlemen, as one who has to some extent been responsible for the inception and carrying out of this gathering, and who has also been primarily responsible for a number of meetings of the American Institute in Canada—going as far back as 1889 and 1891—I have great pleasure in expressing to-night on behalf of the Canadian Mining Institute our appreciation of the efforts, the successful efforts, that have been put forth for the reception and entertainment of our guests not only here in Cape Breton, but also by those mining companies which are represented here from other parts of the Province. I am a profound believer in the great and abundant wealth of our Dominion in natural resources, not only in coal and iron, but in gold and silver and nickel and copper, and all these minerals and metals which make for the greatness of a people, and in promoting this visit to Canada of the American Institute I was inspired by the hope that we had much to gain by asking you to come and see our country again, to become better acquainted with our mining men and to see what progress we are making in the development of these resources. Visits of practical men to our country are the best method of advertising its resources. We trust the next time you visit this portion of Canada the progress you will see will just be as great as it has been since the last time you visited us here, in Nova Scotia, in 1886 ; and I may say that this great expansion in mineral and industrial development is not alone confined to this good old Province of Nova Scotia. In British Columbia, in the far off Yukon and North-West Territories, in Ontario, with its nickel, its iron, its copper and its gold, yes, even, in the old Province of Quebec, we have much still to show you of our progress in mining enterprise. A year or two ago the net value at the pit's mouth of our mineral output reached something like $22,000,000, to-day it is over $50,000,000, and this rate of progress, I make free to say, will be maintained for many years to come. While comparatively speaking, a youngster in years, our Canadian Mining Institute has done not a little towards promoting better mining legislation in Canada, and in bringing together the best elements of the mining profession in the various Provinces of the Dominion. Its meetings are well attended and it publishes annually a volume of proceedings, which will compare, I think, most favorably with any similar organization of its years and membership. I should be pleased to have applications for membership from any mining engineer who is not yet enrolled in our members. In conclusion I would move, Mr. Chairman, that this meeting of the members of the Canadian Mining Institute place on record our grateful appreciation of the hospitalities and courtesies which have been extended to ourselves and to our guests the American Institute of Mining Engineers on the present occasion. (Applause.)

DR. RAYMOND—I would like to second that motion on behalf of the American Institute of Mining Engineers which has certainly taken a large share of the entertainment and ought also to feel as it does a large share of the gratitude, and if gratitude be, as we have been told, a lively sense of favors yet to come then we ought to be doubly grateful in view of the week before us. (Applause.)

The motion was carried unanimously.

NEW MEMBERS.

The following having been recommended by the Council were elected members of the Canadian Mining Institute :—

DR. E. GILPIN, jr., Mining Engineer,
Deputy Commissioner and Inspector of Mines, Halifax, N.S.

PROF. CARR HARRIS, Civil Engineer,
Queen's University, Kingston, Ont.

MR. WM. KOEHLER, Chemist and Metallurgist,
Dominion Copper and Nickel Co., Hamilton, Ont.

MR. WILLIAM L. GRAMMER, Mining Engineer,
Dominion Iron and Steel Co., Bell Island, Newfoundland.

MR. C. H. TOMPKINS, Mechanical Engineer,
American Diamond Rock Boring Co., New York.

MR. E. P. JENNINGS, Mining Engineer,
Salt Lake City, Utah.

MR. W. S, EDWARDS, Mining Engineer,
29 Broadway, New York.

MR. A. E. NOBLE,
Anniston, Alabama.

MR. B. T. A. BELL—I would move that this meeting as a meeting of the Canadian Mining Institute do now adjourn, and as I understand the American Institute has some business to transact, perhaps the occasion would be appropriate for their meeting.

AMERICAN INSTITUTE MEETING.

MR. BELL'S motion having been adopted, Dr. James Douglas, President of the American Institute, took the Chair.

DR. RAYMOND—I have a list of some 30 papers to be presented at this meeting, but as I understand we are to have another meeting at Halifax, perhaps they had better be deferred until then.

DR. DOUGLAS—I would like if some local members would give us some remarks on the resources of the locality.

EARLY COAL MINING IN CAPE BRETON.

MR. JOHN S. McLENNAN—Mr. Chairman, what I know, from an experience of close on 20 years, which, with the exception of one or two, is more than any one here, is about the coal trade. Some 15 years ago the American Mining Institute came here on an excursion from the Halifax meeting. That was, I believe, the first

meeting of the American Institute held in Canada. There were no railroads in Cape Breton connecting with the mainland at that time. There were two railways of ten miles connecting Sydney with the mines. There were five or six different companies operating collieries here, shipping from six to seven months from Sydney harbor. The output was so limited that we looked with anxious eyes at any schooner coming into the harbor to see whether she would come to us or to the rival colliery. (Laughter.) The output was some five, six or seven hundred thousand tons, and that was a rift in the clouds. The General Mining Association, which is represented here by Mr. Brown to-night, has an ancient history beginning early in the century, and there were one or two others which never had the unfortunate episode of a sale by the sheriff, but the other properties had to change hands several times, mostly by forced sale. There was, however, considerable development during the Reciprocity Treaty and times were prosperous, but this was followed by periods of depression during which for a time only one colliery, that of the General Mining Association, was running, and that was exclusively worked for local consumption. This was followed by a gradual development of interprovincial trade about 1879, when we began to send coal into the St. Lawrence. In the early nineties the mines now owned by the Dominion Coal Company had only reached an output of some 800,000 or 900,000 tons. There was not much to do in the winter, and we used to meet at each other's houses and talk over what we would do when the mythical American syndicate came along with many millions of dollars in their pockets. I remember one man who, least he should hand over too great a property to one of these mythical American syndicates to which his mine was under option, refrained for a year from putting a bathroom in his house. (Laughter.) However, there may be a moral connected with that, as he has now retired to ease and affluence, while others who put in bathrooms are still laboring in the coal trade. However, in 1893 Mr. Whitney became interested in the coal industry of Cape Breton, and the chief point of his interest was a thing which has marked all his enterprises, his faith in sound general principles. (Applause.) He felt that coal of a fair quality and suitable for the ordinary purposes for which coal is used, within easy reach of the seaboard all the year round, was bound to become valuable, and all the development which you see illustrates the point at which our president has made a success. (Applause.) This is an example of what Dr. Douglas has referred to. The capital invested in the Dominion Coal Company was largely American, but owing to its success under the able management of Mr. Whitney—the output in 1883-84 was 800,000 tons, and this year it will be 2,250,000 to 2,500,000 tons—when it came to forming the Dominion Iron and Steel Company, owing to the success of his previous enterprise, the great bulk of the capital which has gone into it is Canadian, and this capital was raised in Canada with the utmost ease. (Applause.) While we had the utmost confidence in the physical conditions we felt doubly assured with the benefit of Mr. Whitney's sagacity and ability. He is one of the comparatively few Americans interested. A few years before we had all been seeing the advantages of consolidation but had never been able to accomplish it. (Applause.)

THE CHAIRMAN called upon Mr. R. H. Brown, but that gentleman thought it was hardly fair to call upon him without warning. "All I can say," he continued, "is that the General Mining Association was formed about 1826. When my father came out to this country he took a lease of mines for the General Mining Association in England, and it exists there up to the present time. Mr. McLennan speaks of other companies as having fallen into the sheriff's hands. The General Mining Association has never done that. It is flourishing up to the present moment, except that just now they have sold the property out to another company which will operate it in their place. I have been managing it for the last 36 years." (Applause.)

THE CHAIRMAN—They have large interests both on the mainland and on the Island?

MR. BROWN—They had all the lands in the Province. One of the English Kings gave it to the Duke of York, his brother. The General Mining Association was formed, and in 1857 they made an arrangement with the Province by which they handed over all but what they retained. First of all, they sold out the old Albion mines, subsequently the Springhill Company and the Victoria mine. They retained the Sydney mine.

THE CHAIRMAN—Long ago when I took my first examinations in surgery and anesthetics it was a debateable question as to whether the operation should be performed immediately after the accident or wait until the effect of the shock had passed. I have often felt that that was still an open question, whether to call upon a gentleman suddenly to make remarks or to let him have the prolonged agony of thinking as to what he ought to say; therefore, out of fear we have not advised Mr. Poole that we are going to ask him to make any remarks.

MR. HENRY S. POOLE—My recollections in connection with the coal trade make me feel disposed to look backward rather than forward. To illustrate the smallness of the trade, I may mention one man who went down one day and cut the coal; the next day he was endeavoring to draw it to the surface; the third day he was to ship it and put it on board. (Applause). My experience was not quite as extensive as Mr. Brown, who was the previous speaker, but still in my time I have played many parts. I was for a short period manager of the mine, and at the same time acted as consular agent, then as shipper, and then as health officer, requiring me to make out some 17 papers for the clearance of each vessel. There is one feature of this neighborhood that is of interest, and that is in connection with the vast area that once existed is now only in part available to the coal miner. When you take the map which has been shown on the programme and presented to each member, you will notice that all the seams of coal dip seaward. It has always been a matter of discussion as to how far they do now extend from the shore and how far they may be mined. There has been an erosion of something like three feet a year from the cliffs to the coal fields. That might be a basis of calculation as to how long this denudation has been going on. We know that there are seams of coal dipping seaward that many miles.

Some speculators, anticipating the success of the mechanical engineer, have taken areas lying several miles seaward from shore, in anticipation of ultimately mining the coal contained in them.

THE CHAIRMAN—Is there any distinction between the Cape Breton and the Newfoundland coal?

MR. POOLE—I understand it is supposed to be Lower Carboniferous, not quite the same as the Sydney coal.

MR. BROWN—There seems to be no relation at all between the two coals of Newfoundland and Cape Breton.

THE CHAIRMAN—I know we have all been interested in what we have seen to-day. My particular interest is in copper metallurgy. We see that all the works from the crude article to the finished steel are going to be performed in the small compass of these works of to-day. Most steel works make their coke at a distance and import it to their works, and therefore the works which we have seen to-day seem to be unique. Perhaps Mr. Hinchman would give us some comparative remarks on what he has seen to-day.

AMERICAN OPINION ON THE STEEL PLANT.

MR. C. HINCHMAN, of Philadelphia.—So far as the works we have seen to-day are concerned, they certainly seem to be laid out on the most modern and perfect plans that any engineer could devise, and will produce good results. So far as the works in the United States are concerned, their's has been a varied history. Some of them have been failures by reason of their being located too far from their raw materials or market. So far as mining in the State of Pennsylvania is concerned, we have had the largest development of the steel industry of any single State in the United States, although our Pennsylvania ores are generally better suited for foundry and mill iron than for Bessemer, and we have to draw our supplies from the Great Lakes. Most of the companies west of the Alleghanies draw their ore from the Lake Superior mines. The companies to the east of the Alleghanies draw their stuff largely from foreign sources, from Cuba, from the Mediterranean and from Spain, all of which furnish good Bessemer ore supplies. We who know what coal we have in Pennsylvania think there is hardly any coal to equal the coking coals of Western Pennsylvania for making Bessemer pig. Our coal makes such a quality of coke that it is carried as far west as Chicago and the Mississippi valley for steel making, and will stand considerable transportation. Those of us who are interested in Bessemer works feel that we can live in Pennsylvania after some other parts of the country will have to shut down. I know that the development of Bessemer ore on the Great Lakes is already great enough to supply all our works in the United States, and we are already exporting rails and bridges to China and into Egypt and Australia. Our present Minister to Russia built the first railroad between Duluth and the Iron or Vermillion range, 75 miles back of Duluth, and is entitled to a great part of the

credit for the development which followed on both the Vermillion and Mesaba iron ranges. I am glad to say that his reward came during his lifetime, as he doubled his fortune after he was 70 years of age. I hope Mr. Whitney and his associates may do the same. (Applause.) I have always believed that iron would be found here suffieient to supply all the wants of the eastern part of Canada and to export largely. We found some ore in the Bay of Fundy that analyzed very well, but the trouble was that we could not find enough of it. I never thought of going to Newfoundland, so then we began to look into New Jersey and Virginia for Bessemer ores, and we got very good ore there, but it was a small deposit and finally worked out. We then, in connection with the Bethlehem Iron Company, turned our attention to the development of Cuban ores, being too far east for Lake Superior ores. We developed the Iron Company and built a road from Santiago de Cuba, thirty miles, and that has been for some years the source of the larger supply of the Pennsylvania and Bethlehem Steel Companies. I think that before long we will be exporting pig to England. I do not see why with the shorter distance of transport Nova Scotia should not develop a trade with England and Germany as well as her own. (Applause.) So far as the pig going into the United States is concerned, we should have to have reciprocity between Canada and the United States before that could be brought about, our high duty preventing the importation of any but special brands in small lots. Twenty years ago the well known iron master, Abraham S. Hewitt, favored reducing the duty upon pig from $7.00 to $3.50 per ton, but we were not ready for it at that time. Had that been adopted I believe we would have had a more stable business and fewer booms and depressions than have occurred in the iron business due to undue stimulation and attraction of furnaces where they could not be profitable without a duty. (Hear, hear.) When our late lamented Alexander L. Holley was superintendent of the Pennsylvania Steel Works, we had a call from the general manager of the Cammell Company, the foremost steel makers of Sheffield, England, shortly after Mr. Holley had introduced the three shifts in the 24 hours, thereby increasing the product 50 per cent. over anything that had heretofore been done abroad. So far we have managed to export our surplus, and I think that both China and Japan are going to open up a very large market to the steel works of the world. It was my duty at that time to go with Mr. John Fritz and others to Russia and consider the plans for building steel works to supply the rails for the Pacific Trans-Caucasian system, a road since completed by the Russian Government to the Pacific. We found deposits of Bessemer ore, some of which have since been developed, at Krivoi Rog. The engineers reported that the coal examined was more broken up than we had expected to find it, all the veins in Southern Russia pitching at steeper angles than we were accustomed to in Pennsylvania, but the conclusion our gentlemen came to was that the application of the same amount of brains, money and energy would pay as well in our own country. The opening up of China, which we are now entering upon, is going to afford a great market for the surplus products of all the leading nations. In the next ten years I should not be surprised to see 10,000 miles of railway built in China. They need it. There are 400,000,000

of people there, and they will readily consent after they have seen the necessity and the advantages of it. (Applause.)

DR. R. W. RAYMOND—Remembered when in 1873, as first president of this American Institute of Mining Engineers, he attended a meeting at Liege, in Belgium, he told them that if they came to America he would show them Bessemer converters making 25 tons a day where before they made 15. This iron master to whom Mr. Hinchman referred was afterwards going over the works of Edgar Thompson, jr., when he was told that he would not find an ingot in the works that was cool enough to sit on. That was the history of the Bessemer works in those times, and I think that Alex. Holley took the English industry by the scruff of the trousers, and when they were making 15 tons a day we were making 25 ; when they went up to 25 we were making 50 tons a day, and when they made 50 tons we went up to 100, and they sent a man to Bethlehem to remodel his works, and who made 100 when we were making 250. We forced the tail of the procession to march. (Applause.)

MR. HINCHMAN—As an illustration of the growth of the industry, I may say that it was originally more trouble to furnish a railroad with ten tons of rails than it is now 100,000 tons. Mr. J. Edgar Thompson, the far-sighted president of the Pennsylvania road, has probably done more to establish the steel industry of this country than any other single railroad man, and most of them have followed in his footsteps, but the man who is chiefly entitled to credit for mechanical development was Mr. Alex. L. Holley, who brought the Bessemer patents to this country.

THE CHAIRMAN—I suppose we have been rather slow in discarding the beehive oven and adopting the coke oven, which saves the bi-products, and possibly the only place where coal is coked and made in pig iron and in basic steel is in Alabama. I would like to ask Mr. Fraser as to the probable source from which they expect to draw their ore and the probable amount in sight to run these works upon —to give us some statistics as to their source of supply and probable production.

MR. GRAHAM FRASER—Dr. Raymond said that these great works had sprung up suddenly. No doubt they have developed very suddenly at the end, but still some of us who were living in Nova Scotia thought that if we could only get clear of the sulphur in the coal here in Cape Breton we had one of the best places in America for making iron. If you take the map you will see that Sydney is very nearly the centre, is more than half way across the Atlantic from New Orleans and ports in the Gulf. The coal after being coked pretty cheap was found free enough from sulphur for making iron. Then came the question of limestone. Well, the country is full of it. Having the coal in abundance and the limestone, then came the question of ore. Well, the Bell Island mine with the development of which I had something to do is very good ; that is, the ore can be mined very cheap and is all right for basic steel and foundry pig iron. Another point is that this place being a very central point to make basic pig iron, it is possible to use Lake Superior ores right here. Since the canals have been deepened to 14 feet, coal can be sent up to the

head of the lakes and ore sent down at a very low rate, under a dollar a ton. I doubt very much if Mr. Carnegie can get his ore to his furnaces as cheap as Mr. Whitney can get his ore here. Now there is this advantage for export, that while the lakes are frozen six months in the year, the harbor of Sydney is only frozen about four months, and Louisburg is open nearly all the year, and the Strait of Canso, only 70 miles away, is one of the best harbors in the world. The ore has got to be taken down from the head of the lakes to Cleveland or any of the lake ports in a short season, while here we have a long season. I think, therefore, that we stand in a very good position. Certainly the deposit in Newfoundland is a very cheap ore, but even going beyond that, the business would stand the Lake Superior ore altogether, and there have been some very large deposits developed lately on the Canadian side of Lake Superior. (Applause.)

THE CHAIRMAN—What you say is certainly extremely interesting. I could not help pointing out at the Congress in Paris to our European friends that if they would change their methods of transportation they would be in as good a position as the Americans. Take Northern Sweden, some 250 miles away, where there is 60 to 70 per cent of ore, and then there is a seaboard of 150 miles open all winter. They could do it just as well as Lake Superior if they would change their methods of transportation. I think down here you are certainly using the means at your disposal to very great advantage.

MR. FRASER—The ore in Conception Bay is very similar to the ore in Alabama, perhaps higher in iron and in phosphorus. The iron of that ore in Alabama will be something like $1.00 a ton. I think we can make it cheaper here. With regard to the Lake Superior ores being the same as ore used in Pennsylvania, I think the iron could be made as cheap and probably cheaper here.

The meeting shortly afterwards adjourned.

WEDNESDAY—THE COLLIERIES OF THE DOMINION COAL CO., LTD.

Probably one of the most enjoyable visits of inspection made by the party during the entire excursion was this day spent in a visit by special train over the Sydney and Louisburg Railway to the extensive collieries of the Dominion Coal Company and to the historic old town of Louisburg. The Company owns 160 square miles of coal leases, and the aggregate thickness of workable coal is 30 feet in known seams, together with water leases, making 3,000,000,000 tons of workable coal. Mr. John S. McLennan, treasurer; Mr. Hiram Donkin, resident manager, Mr. Thomas J. Brown, assistant to manager, and other officials who accompanied the party, left nothing undone to make the inspection both pleasant and profitable.

The following notes on the collieries visited will be of interest:—

DOMINION No. 1 COLLIERY.

Seam Phalen, 8 ft. thick, dip 1 in 14 *Mined*, pillar and room, with Puncher type mining machine, driven by compressed air. *Haulage*, endless rope 1 in. dia.,

engines (2) 18 x 36 in., speed 3 miles per hour. *Shaft*, 157 feet deep, 24 feet long, 10½ feet wide, 4 compartments. *Hoisting*, coal engine, 2-20 x 54 in., rope 1¼ in. dia. *Ventilation*, 2 fans, Murphy's, 12 ft. dia. and 8 ft. dia., engine, 11 x 16 in. *Compressors*, 3, Ingersoll's Coreless engine, compound m. steam 22 in. air, 22 and 36 in. steam by 42 in. stroke. *Bankhead and screens*, bankheads of steel fitted with screens of the shaking and knocking type and picking table. *Motive power*, 5 Babcock & Wilcox boilers of 212 h.p. units and 2 of 318 h.p. units, making 1,700 horse power in all.—Boilers operated by mechanical draft. Monthly output, 60,000 tons (2,240 lbs.).

RESERVE COLLIERY.

Seam Phalen, 8 ft. thick, dip 1 in 12. *Mined*, room and pillar, partly by punching machines and partly by hand. *Haulage*, endless 1 in. rope, engines 22 x 42 in. *Slope*, French slope, 5,000 feet long; main slope, 5,600 feet long; south slope, 1,600 feet long. *Ventilation;* Chandler fan, 15 feet dia., engine 16 x 18 in. *Bankhead and screen*, wooden, with shaking and knocking screen and picking belts. *Motive power*, 2 Babcock & Wilcox boilers of 318 h.p., 2 B. & W. boilers of 212 h.p., and 2 ordinary tubular boilers. Output monthly, 65,000 tons (2,240 lbs.).

INTERNATIONAL COLLIERY.

Seam "Harbor," 6 feet thick, dip 1 in 12. *Mined* by hand picks, room and pillar. *Haulage*, endless rope, 1 in. dia., engine 1—18 x 36. *Shaft*, 90 feet deep, 14 feet long, 6 feet wide, 3 compartments. *Hoisting*, rope 1¾ in. dia., engine, 2—17 x 42 in. *Ventilation*, fan, Murphy, 8 feet dia., engine, 1—9 x 12 in. *Bankheads and screens*, wooden bankhead with transfer truck for mine cars and ordinary gradient screens. *Motive power*, 1—212 and 1—318 h.p., B. & W. boilers, 1 Lancashire 7 feet dia. x 30 feet. Monthly output, 25,000 (2,240 lbs.).

DOMINION NO. 2 COLLIERY.

NOW SINKING.

This shaft is in the course of sinking. Coal shaft 37 x 11—400 feet to the Harbor seam, and from that 21 x 11, 500 feet to the Phalen seam. Air, pumping and man shaft 34 x 11 feet, 900 feet to the Phalen seam. This coal shaft is to be divided into compartments, 2 compartments for each seam, and is to have an output of 6,000 tons (2,240 lbs.) per day. The mine tub is to carry 3 tons, and to be weighed and tipped in the pit bottom, the coal being raised in self-dumping coal tanks with a capacity of 6 tons each. The coal will be hauled to pit bottom by electric motors. Bankheads of steel 125 feet high. All machinery to be of the most modern type. 4 boilers (being built) Babcock & Wilcox, 318 h.p. unit each. 2 hoisting engines (being built by Dickson, Scranton) 34 x 48 in. 1 fan and 2 single engines (being built by Dickson, Scranton) 24 feet fan and 20 x 42 in. engines. 2 compressors (being built by Walker in Wigan) duplex compound high pressure steam 31 in.; air 32 in.; low pressure steam 57 in., air 51 in. and 60 feet stroke.

CALEDONIA COLLIERY.

Seam Phalen, 8 feet, thick, dip 1 in 14. *Mined*, room and pillar, partly by hand and partly by puncher type of coal cutting machines. *Haulage*, 1 in. wire rope, endless system, engine 1—23 x 42, about 12 miles of wire rope on engine. *Shafts*, 182 feet deep, 17 feet long and 11 feet wide, 3 compartments. *Hoisting Coal*, rope 1¼ dia., engine 2—20 x 48 in., cages self-dumping. Rope 1¼ in. dia., engine 2—18 x 24 in. *Compressors*, Rand compound in steam and air, L. P- steam and air 48 in., h.p. steam and air 22 in. stroke 60 in., one small Ingersoll 20 x 20 x 30. *Ventilation*, 1 fan, Murphy, 12 feet dia., 1 fan, Dickson, 15 feet dia. *Bankhead and screens*, steel bankhead, shaking and knocking screen, picking tables. *Motive power*, 5 Babcock & Wilcox boilers of 212 h.p. units or 1,060 horse power. Monthly output, 58,000 tons (2,240 lbs.).

DOMINION NO. 4 COLLIERY.

IN COURSE OF SINKING.

Seam, Emery, 5 feet thick, dip 1 in 10. *Mined*, room and pillar, puncher coal cutting machine. *Haulage*, endless rope 1 in. dia., engines (1) 24 x 54 in. *Slope*, 1 in 12. *Motive power*, 2 B. & W. boilers, 624 h.p. mechanical draft. *Ventilation*, Champion fan, 8 feet dia. *Compressors*, 2 small Rands, 18 x 20 x 30. *Bankhead and Screening*, of wood, knocking screens, air tipples and picking belts, driven with rope, driven by engine, 18 x 36.

DOMINION NO. 3 COLLIERY.

IN COURSE OF SINKING.

Seam Phalen, 8 feet thick, dip 1 in 14. *Mined*, room and pillar by puncher type of coal cutting machine, driven by compressed air. *Haulage*, 1 in. rope, engine 24 x 54, coal hauled by endless rope overground to Dominion No. 4 bankhead, a distance of 1 mile. *Slope*, 1 in 2. *Ventilation*, Murphy fan, 6 feet dia. *Compressor*, small Rand, 18 x 20 x 30; duplex compound compressors being built in Wigan, England, for this colliery. L. P. steam 57 in., air 51 in., h.p. steam 31 in., h.p. air 32 x 60 in. stroke.

COAL WASHING PLANT.

Coal Washing Plant consists of 2 Robinson Ramsay coal washers, with a combined capacity of 2,000 tons of washed coal per day, one built in 1897 and the other in 1900. The slack coal is brought from the mines in cars and dumped into bins under the track, having a storage capacity of 1,200 tons, and from which it is drawn by two cable conveyors to the centre of the bins. From here it is elevated to the top of the wash house, and divided between the two washers. An average of 41 per cent. of the contained ash and 28 per cent. of the sulphur is removed by this process. Coming from the washers the coal is carried over screens and the water drained into the sludge tanks, from where it is pumped by four pulsometers of 1,000 gals. per min.

capacity each, back into the washer, and is used over and over again. After passing over the screens the coal falls into another elevator which takes it to the washed coal storage bin, holding 1,800 tons, and from here it is trapped back to the cars. Power is furnished by 4 return tubular boilers, 5 x 14 feet; water is piped from a lake, 3,000 feet from the plant.

LUNCHEON AT DOMINION NO. IV. COLLIERY.

After a very thorough inspection of the surface plant and a visit underground at Caledonia, the company was entertained to luncheon in the large dining room at Dominion No. IV. The tables were handsomely decorated, and the miniature Union Jacks, Stars and Stripes and Canadian flags greatly enhanced the pleasing effect. Mr. John S. McLennan, treasurer of the company, presided, and seated around him at the table of honor were Dr. Douglas, president of the American Institute; Mr. W. L. Libbey, president of the Mining Society of Nova Scotia; Mr. Charles Fergie, vice-president, and Mr. B. T. A. Bell, secretary, of the Canadian Mining Institute; Dr. Gilpin, inspector of mines; Mr. J. F. Lewis, and Mr. Hiram Donkin, resident manager of the company.

After the luncheon, at the request of Mr. McLennan, the resident manager, Mr. Donkin, delivered the following address of welcome:—

ADDRESS OF WELCOME.

To the Visiting Members of the American Institute of Mining Engineers, the Canadian Mining Institute, and the Mining Society of Nova Scotia:—

Ladies and Gentlemen,—On behalf of the Dominion Coal Company, Limited, we its local officers extend to you a very cordial welcome. Such an opportunity as this seldom presents itself to an organization such as the Dominion Coal Company, and we find it hard to express in modest language our high appreciation of the visit of this body of representative and distinguished men, embracing as it does leading scientific mining men of both the United States and Canada, By to day's visit you will have seen for yourselves to what extent and with what success the Dominion Coal Company is mining coal in this locality, but to fully realize the situation and understand the progress being made it is only necessary to refer to the fact that this company was but inaugurated in 1893, the output of coal for that year being eight hundred thousand tons, and that in the last year of its operations the output had risen to one and three quarter million tons, and for the present year it will reach a total aggregate of two and one quarter millions, and when the new shaft known as Dominion No. 2 which you have just visited, and the new slopes near which we are now standing, shall have been developed, together with the improvements in progress at the older collieries, the output for the incoming year is expected to reach three and a half million tons. We are here situated on the Atlantic seaboard with harbors capacious and accessible within the limit of our operations, and you are now standing in the centre of a coal basin which is known to contain workable coal

to the extent of three thousand million tons, the company's leases covering one hundred and sixty square miles. In the early history of this company its most serious problem was to furnish a market for its product, and consequently employment for its workmen all the year round. This great problem has been happily solved by the genius of its president, Mr. Whitney, who has changed the old condition of things of eight months labor and four months idleness to continuous work throughout the year, and from having its product seek a market to having the market seek for its product. In conclusion we shall feel pleased if we have contributed even in a small way to the pleasure of your visit and take this opportunity of extending to one and all a cordial invitation to repeat your visit at no distant date. I am, ladies and gentlemen, in behalf of the Dominion Coal Company (Limited), and its local officers, yours cordially.

HIRAM DONKIN.

MR. JOHN S. McLENNAN—On behalf of the President and Directors I wish to extend the same welcome, and to say what pleasure it gives to have you here, and to express Mr. Whitney's regret that he was unable to be with us. (Applause.)

DR. DOUGLAS—Mr. Chairman, ladies and gentlemen, I am perfectly sure that your welcome is just as warm as the high class of coal that you mine to generate heat. In thanking you as our hosts we have likewise to thank you as coal miners, for, after all, coal is the great unifier, and the coal miner is a far more potent politician than all the orators of all the representative bodies of the world put together. If you look across the line and consider what the United States was within our memory, you will recollect that we were divided into sections. There was a manufacturing section in the east which made a tariff, and there was a cotton-bearing section in the west which reversed the tariff. Then we had a west which was supposed to be exclusively a food-raising section. Look at them to-day. There is no manufacturing section, there is no specifically cotton-raising section, there is no purely food-raising section. All that distinction between the manufacturing States and the food and cotton producing States has disappeared, and how? Simply through the agency of coal. Coal has brought about what all the politicians could never have effected, that is, a homogeneous unification of the country. Another grand influence of the coal industry has been the linking of one section to another by our wonderful railroad system, which would simply have been impossible without the agency of coal and that coal distributed far and wide throughout the land, and I think we can predict without being either prophets or sons of prophets that that very same influence which has brought about this result on the other side of the land will tend to unify the whole continent. For if you look at the situation as it is to-day, we have these magnificent coal resources here in the Lower Provinces. New England is bereft of that advantage. On one side of the lakes we have magnificent coal fields, on the other side of the lakes we have none. Naturally, therefore, the coal from the Lower Provinces should not cut off from Ontario the coal supply that nature intended her to use. It is not likely, therefore, that the perversity of man will long stand against nature, and I thiuk,

therefore, that those of us who are not soon to drop into the grave will see this unification brought about by that same potent force that is unifying the whole land to the south of us. Therefore, I think that I can congratulate you gentlemen not only on the noble work you are doing here as coal miners, but on the vastly greater work you are doing as true patriots and politicians. (Applause.)

MR. CHARLES FERGIE—Mr. Chairman, ladies and gentlemen, after the interesting remarks of Dr. Douglas I do not think there remains much for me to say. I am sure that you are all interested in watching the progress of the Dominion Coal Company and its development. I remember when the Whitney syndicate took over these properties with Mr. Donkin, there were some 800,000 tons being produced, and this year it is something like 2,250,000, and I think I will be safe in predicting that you will yet see an output of certainly five million tons at no very distant date. There is no possible reason why it should not be done. There is no doubt that coal can be worked cheaper in Cape Breton than in any other place. In Pictou county we are not so well placed, and although we looked upon the Whitney syndicate as going to wipe us all out I have no hesitation in telling you that we have been benefited. We will follow in their wake, and what is profit to them we will have a certain share of it. I am very pleased to have made the visit to-day, and on behalf of the Canadian Institute I thank you very much. (Applause.)

MR. W. L. LIBBEY—Mr. Chairman, ladies and gentlemen, I do do not see that I can give you any statistical information that will be of benefit. I am a little different from the gentlemen associated with you, being a metalliferous man instead of a coal miner.

MR. FERGIE—That is where you have the advantage.

MR. LIBBEY—Distance lends enchantment to the view. The pleasure, however, that I have in this visit is almost without measure, and the hospitality that we have received is something that each individual member of the Mining Society of Nova Scotia appreciates. We appreciate also at what personal cost to every individual officer of the Dominion Coal Company this entertainment means. It means an amount of personal labour that can hardly be estimated. We cannot help but think that every individual official has conferred a personal favour on every one of us. For the amount of labour we have to sincerely thank you. (Applause.)

EXCURSION TO LOUISBURG.

The remainder of the afternoon was spent in a delightful run over the Sydney & Louisburg Railway to Louisburg. A short inspection was made of the fine shipping pier of the Dominion Coal Company at this point, The Robins Belt Conveyor and Slack Pocket now being built here will increase the shipping capacity by at least 50 per cent. The party was next towed in a schooner over to the site of the old fort of Louisburg. Here, under the guidance of Mr. John S. McLennan, the treasurer of the Dominion Coal Company, who explained the many points of interest and delighted the visitors with historical reminiscences of the stormy times around the old

fort during the seventeenth century—a delightful hour was spent among the old ruins. On returning to the pier three rousing cheers were given for Mr. and Mrs. McLennan and for Mr. Donkin and the officers of the Dominion Coal Company. On the return journey a brief stop was made at the coal washing plant at Morien. Sydney was reached early in the evening.

THURSDAY—THE BRAS D'OR LAKES.

Through the courtesy of the Mayor and Corporation of the town of Sydney and the officers of the Dominion Iron and Steel Company, the visitors were entertained to an enjoyable sail on the steamer "Pawnee," past North Sydney into the Atlantic Ocean and down by Boularderie Island into Little Bras d'Or Lake, passing the pretty little resort of Baddeck and the summer residence of Prof. Graham Bell, the inventor of the telephone, which is beautifully situated on a magnificent point in the lake facing Beddeck. A stop was made at his wharf for water, and the visitors went ashore and inspected the immediate surroundings. It was noted that even during his holiday seasons Prof. Bell must needs have a workshop fitted up for experimenting purposes. It had been intended to also go through the Great Bras d'Or Lake, and on through St. Peter's channel, Lennox Passage and the Strait of Canso, joining the special train at Mulgrave, but time would not permit, so that the party disembarked and joined the train which was held for them at Grand Narrows.

Previous to disembarking, Dr. Douglas, president of the American Institute, said: Ladies and gentlemen, I am sure we are all at one, whatever we may differ in opinion, in according our hearty and sincere thanks to the citizens and corporation of Sydney who have placed this boat at our disposal, and the Dominion Iron and Steel Company who have supplied the inner man. I am almost beginning to fear for the stability of our Institute. It was started as an institution for the discussion of purely scientific subjects, and it was therefore to be supposed that only those would join who had no other motive in doing so but to advance science and art, but if this sort of thing continues I fear that we may deteriorate into a junketing party. We find wherever we go, to the east coast or to the west, to the north or to the south, the same open-handed hospitality, and I am afraid that people will join the Institute in the future, not because they are expert miners or metallurgists, but because they have a good time at other people's expense. (Cries of "No, No.") Certainly the hospitality which we have received does call for this thanks and on this occasion for three hearty cheers (Applause), and to all the gentlemen who have individually and collectively been kind to us we return our sincere thanks.

FRIDAY—PICTOU COUNTY.

At New Glasgow on Friday morning the party divided, a portion going to the Drummond Colliery at Westville, and another to the Acadia Coal Company's mine at Stellarton, while the ladies and others were driven by courtesy of the Citizens Committee over Fraser's Mountain and other points in the beautiful countryside for which Pictou County is so famous.

AT THE DRUMMOND COLLIERY.

A large party visited the Drummond Colliery of the Intercolonial Coal Company, Limited, at Westville, leaving by special train from New Glasgow about nine o'clock in the morning. They were accompanied by their genial host Mr. Charles Fergie, M.E., managing director of the company. At the Drummond Colliery the main and second seams are worked, the fourth being intact. The second seam is only in process of being opened up. The main seam is worked by slopes 12 x 18 feet, having an average dip of 16 degrees and are 5,400 feet long. The seam is worked on the longwall system : each lift is 450 feet ; the levels are S.E. and N.W. 20 degrees ; the dip is 24 degrees on the north and 19 degrees on the south side ; counterbalance planes are driven every 300 to 400 feet. The main levels of every lift are driven out to the extreme boundary, and the coal is then worked by longwall retreating. No explosive is used, the coal being worked by maul and wedge. The coal is good for steam and household purposes and makes excellent coke. The annual output is about 250,000 tons. The plant is in every respect admirable and up to date, and in keeping with the sound mining practice for which Mr. Fergie is famous. After inspecting the surface and underground works of the company the party adjourned to the beautiful residence of Mr. and Mrs. Fergie where luncheon was served.

The visitors appreciation of Mr. and Mrs. Fergie's kindness was very neatly and appropriately expressed by Mr. J. Stevenson Brown, treasurer of the Canadian Mining Institute. Mr. Fergie having briefly acknowledged the vote of thanks, cheers were freely given for Mr., Mrs. and Master Fergie, and the party returned to New Glasgow.

THE ACADIA COLLIERY.

In the meantime a smaller party had gone over to the adjacent collieries at Stellarton, operated by the Acadia Coal Company, Limited, where they were received by Mr. Henry S. Poole, M.A., Assoc. R.S.M., the general manager, and by Mr. J. Geo. Rutherford, M.E., his able assistant. Mr. Poole, who is an eminent geologist, pointed out the many interesting features of the coal measures of the district and conducted the visitors over the principal surface works. At the Acadia a seam of 10 feet is worked by a slope 4,200 feet, the dip averaging 27 degrees. The method of working is in lifts of 300 feet, longwall with timber packs 5 feet square. The Albion colliery main seam is 38 feet thick ; 148 feet lower deep seam 22 feet thick. The Foord pit shaft is 900 feet deep being sunk to the main seam. The output in 1899 was about 270,000 tons.

NOVA SCOTIA STEEL WORKS.

Shortly after noon the whole party were hauled by rail over to the works of the Nova Scotia Steel Company, Limited, where they were received by Mr. Graham Fraser, vice-president ; Mr. Harvey Graham, secretary ; Mr. Thomas Cantley, and several other officers and directors of the company by whom they were conducted

over the extensive works. The plant here comprises four Siemens melting furnaces, ranging from twenty-five to fifty tons capacity, three gas reheating furnaces, reversing cogging mill with live rolls and hydraulic ingot manipulators, hot bloom shears with live rolls, one 20-in. plate mill, one 16-in. bar mill, one 12-in. bar mill, one 9-in. guide mill, twelve pairs of shears, forty tons and smaller, one five ton hammer with fifteen ton hydraulic crane, four steam hammers of smaller size. Machine shop 175 x 75 feet, with thirty-ton travelling cranes, commanding the whole shop. The machine shop is equipped with 30-in. slotter, 9 ft. radial drill, twelve laths of various sizes, the largest taking 50-in. over the carriages, with a gap of 8 x 10 feet and 37 feet between centres. Power for the entire plant is supplied by some seventy steam and fifteen hydraulic cylinders. The entire plant is lighted by an electric plant installed at the works. The output consists of upwards of one hundred and fifty steel ingots per day, all of which are worked up into bars, sheets, axles and forgings. The company also operates a blast furnace plant of modern design, at Ferrona, and also mines of red and brown hematite on the East River, some thirteen miles distant from the furnaces. The output from these mines is from 4,000 to 5,000 tons per month. It also owns and operates one half of the great red hematite deposit at Bell Island, Conception Bay, Newfoundland (described later on). The coal washing plant of the company is situated near the furnaces at Ferrona. About 50 per cent. of the ash in the coal is removed, besides about 60 per cent. of the sulphur. The capacity of the coal washing plant is about 900 tons of washed coal per day. The coking plant, also at Ferrona, consists of 54 retort coke ovens of the Bernard types. During 1899 the company made 31,100 tons of pig iron, 23,000 tons of steel, and 3,500 tons of forgings. In this production were used :—140,000 tons of coal, 24,300 tons of Canadian ore, 32,900 tons of Newfoundland ore, 1,100 tons of Cuban ore, 45,000 tons of coke, 24,000 tons of limestone. It employed 750 persons and paid out over $300,000 in wages. The profits during that period amounted to $819,945.19. During the present year the company acquired the valuable coal mining property at North Sydney, successfully operated for a great many years by the General Mining Assso-ciation, Limited.

EXCURSION ON PICTOU HARBOUR.

The inspection of the works completed, the visitors, accompanied by a large party of invited guests from New Glasgow and the surrounding neighbourhood, were entertained to a most delightful sail in the steamer "Princess," which had been chartered by the Nova Scotia Steel Company for the occasion.

Among others who accompanied the party were Mr. D. C. Fraser, the genial and large hearted M.P. for Guysborough; Mr. Ed. Macdonald, M.L.A.; Mr. Graham Fraser, Mr. Harvey Graham, Mr. Thos. Cantley, Mr. J. D. MacGregor, Mr. W. G. Matheson, and these gentlemen were unremitting in their efforts to make things pleasant for everybody. Nor while memory lasts can we ever forget the galaxy of bonnie lassies from Pictou and New Glasgow, and their splendid impromptu

concert of Scottish song, sung with a vigor and heartiness and expression which would be hard to beat. Another feature of the afternoon was the Westville band whose selections added in no small measure to the pleasure of the company. Altogether that afternoon in the bright sunshine off Pictou harbour will linger long and pleasantly in the memories of all who were privileged to be the guests of the Nova Scotia Steel Company.

Previous to reaching the wharf, Dr. Douglas, president of the American Institute, stepped to the front and said: Now that our pleasant little trip around this beautiful harbor is drawing to a close, we of the American Institute of Mining Engineers feel it a pleasure to return our sincerest thanks for the unbounded hospitality that you have shown us. I believe to-day that we owe the pleasure of this trip to the Nova Scotia Steel Company, the Acadia Coal Company, the Intercolonial Coal Mining Company, and Messrs. I. Matheson & Co. Limited, of New Glasgow. To these gentlemen more particularly, therefore, we wish to return thanks. It is fortunate that we are not called upon to fill our glasses and empty them to all those who have been so kind to us or we might have all been under the table before we got here. The mention of Pictou recalls to me early memories. I am a Quebec man, and in my boyhood days Pictou loomed large before us, for it was the port through which our mails to Europe always went. Most of you perhaps forget the incident when Captain Walter Douglas, the commodore of the Cunard line in 1842, two months before the regular line was established, brought over the SS. Unicorn from Boston. It came round to the gulf and was established as a branch line of the Cunard Company, and for five years the mails went from Pictou to Quebec, whence they were transferred by land to Halifax and picked up by the regular steamer to Boston. Capt. Walter Douglas was sailing master of the Gulnare under Capt. Bayfield when he made his survey of the St. Lawrence, and on that account he was selected by the other company for their commodore and commander of the Unicorn in the St. Lawrence. The week before last, old Mr. Huntington was marching with elastic step about Wall street, New York, when he was asked by some one how it was that he came down in such hot weather and could be as cheerful and chirpy as he was. "Oh, well," he replied, "I take life as it comes; I never regret yesterday and I never look forward to tomorrow." I do not think those principles actuated him all through life. Had he done so he would never have looked ahead and become the proprietor of the Southern Pacific Railroad. I do not think it is wise to follow that precept, but we should rather look forward with hope and assurance. I am not an extremely old man, and I do not wish to consider myself such, but I was born the same year as the city of Chicago. I saw as a baby the city of Chicago as an incorporated village in 1837. About that time there were a number of little blast furnaces making about as much as one of the Duquesne or even the South Chicago furnaces make today. Now, then, I do not think that we can look forward to Pictou a life hence as likely to rival Chicago, although Pictou has advantages that Chicago

did not possess, although she has labored under disadvantages that Chicago did not. There is no spot on this continent within county limits where you have coal, malleable iron ore and shipping ports all within county limits. These advantages give Pictou, therefore, a prospect for the future, which although they may not rival Chicago undoubtedly should lead everybody in Pictou to do his best and make the most of these marvellous resources. And therefore in bidding you good-bye we do so with the hope and with the assurance that, having the resources that you have and being peopled with the people who inhabit it, the prospects of Pictou in the past will be more than rivalled by Pictou in the future, and that Pictou county will become one of the notable spots on the North American continent. Now, gentlemen, I for my part bid you good-bye with the most hearty wishes for your future. As I said before, I am an old Quebecer and feel very proud of my birthplace and my country. The next Douglas that I hope you will greet will be Admiral Douglas, my cousin, when he will be placed in charge of the North American squadron. Today he is a second Lord of the Admiralty, and I hope that when he becomes a vice-admiral we will see him out here in that conspicuous position. (Applause.)

Dr. R. W. RAYMOND—Mr. Chairman, ladies and gentlemen, a little while ago I thought it would be a great privilege to follow my friend, Dr. Douglas, and express some of the sentiments which fill the hearts of all the citizens of the United States. I can give Dr. Douglas a simple reason why we are not all under the table. We were told in Sydney the other day that it was somewhere between New Orleans and Liverpool, and therefore if we were half seas over what was the need of going any further. (Laughter.) Dr. Douglas has also told you that he was born the same year as the city of Chicago. Well, we all love him very much, and we all hope that his career will not parallel that of the city of Chicago which was burned up a few years ago and we trust that his conflagration will never, never arrive. (Laughter.) Without giving any special acknowledgment to any of the innumerable friends and corporations that have done so much to make our stay in the Province of Nova Scotia delightful and profitable, I must express the thrill of delight with which we have come into the atmosphere of this old and ancient province which brings us into touch with the old Breton fishermen and with the old covenanters, this province which with all the air of enterprise carries still the reminiscences of the past, and the beauty and the heroism and the ancient memories of undying hopes, the most splendid hopes of the noblest souls. We have shaken hands at Quebec with the sons of New France, and today the songs of old Scotland have been sung in our ears. As the sons of New France and the sons of New Scotland, New England greets them both to-day, and joins with them in the hand clasp of eternal friendship. (Applause.)

Mr GRAHAM FRASER being called upon, said :—I do not make speeches. I am a practical man ; but I have a small sized boy that I have brought with me for making speeches, and I am going to call upon Mr. D. C. Fraser, M.P.

Mr. D. C. FRASER, M.P.—Mr. Chairman, ladies and gentlemen, I hav

heard of a man travelling with a private chaplain, but never with a private speech-maker. But I wish to say something, and I wish it to appear as if he were not here, and it is this, that I wish my United States friends who are here to know that there is not in Canada or anywhere else a better man than that same Graham Fraser. (Hear, hear.) With him silence is silver and speech is golden, but he is of the metal which makes a great nation of this Canada of ours. I do not wish to make a speech, but I would like to say that while I want you all to carry away the best impression of this country of ours, lest there should linger in your minds that sentiment that sometimes finds place in the United States, I wish to add that while our attachments are with you as brothers across the line, we in this country of ours are perfectly able, as we think, to get along ourselves. (Hear, hear). Let not one single man living in the United States think that there is a man, woman, or child in Canada—because we teach our children so—who thinks there is any need now or at any future time for any attachment except the friendly rivalry that makes for the progress and welfare of any great nation. (Applause.) Our population is a small one, but we think we possess resources equal to anything they can show, and we think we have all the riches in this Canada of ours sufficient to make a nation and fit ourselves to dwell in amity and goodwill with them and with all the world. (Loud applause). We love them in that higher and better sense; if there is any young man who longs for that which makes life happy, if you want the chosen of the earth, look about you. (Applause). There was no nation ever great that did not live in northern latitudes. We can produce just as fine a people as exist; there are no finer than ours. I want also to say that when Mr. Bell moved in this matter I joined in it with all my heart and soul, because I know of no better way of having the people of Canada and the people of the United States understand one another than having just such people come to this country. We are not afraid in the slightest degree, because we have got something to show them. Just look at the bloom of health about you. (Hear, hear). Speaking of poetry and art, if you wish to wander amid Acadian bowers and arcades where lovers can enjoy all the luxuries of present happiness and anticipation of eternal joys with the loveliest women you ever saw on this or any other continent, you could not do better than to come and see us. (Hear, hear). We are not able to go in such large numbers as you, nor have our men engaged here the opportunity, but none such as we have here today will ever come to Nova Scotia without the warmest welcome. We receive you as people of the same tie and united by blood, and notwithstanding the attempts made by some of the people of your country who tried to step over and take us, and which was prevented by the march of British sons who are ever in the forefront in support of all that tends to liberty, civilization, and commerce and friendly intercourse. Let each work out their own destiny, and we shall feel, as you feel, the all-mastering power of the British flag. (Loud applause.)

Mr. FERGIE—I will not detain you, ladies and gentlemen, but I simply want

to endorse what has already been said, that we welcome our American friends with the utmost cordiality, and we know that if we go to visit on the other side of the line we will get as warm a welcome there.

Before disembarking, on the motion of Mr. B. T. A. Bell, three hearty cheers were given for the ladies, after which "Auld Lang Syne," "Our Country, 'tis of Thee," and the "National Anthem," were sung by the company. At New Glasgow the special train was again taken and after a smart run Halifax was reached shortly before midnight.

SATURDAY, HALIFAX.

The headquarters of the visitors was the Halifax Hotel, where the Mining Society has a comfortable room equipped with technical literature.

By courtesy of the officers and members of the Society, the party were driven, in the morning, to various points of interest, a pleasant half hour being spent in the beautiful public gardens for which the city is noted. In the afternoon, by the courtesy of Mr. Mat. Morrow, they were entertained to a delightful sail on the ss. Coban, one of the boats of the Dominion Coal Co. In the evening they were guests at an exceedingly bright performance given by amateurs at the Academy of Music.

Sunday morning parties visited the Citadel and the various church parades. In the afternoon they were taken out in a steamer to H.M.S. Crescent, and through the courtesy of Lieut. and Acting Commander Gillett they were shown the many interesting features of this fine cruiser. Lieut. Gillett having entertained the party to cake and wine in the gun room everybody left the ship greatly pleased with what they had seen, with the uniform courtesy of the officers and men, and particularly with a lively sense of appreciation of Lieut. Gillett's kindness.

MONDAY—MEETING OF THE AMERICAN INSTITUTE.

A meeting of the American Institute of Mining Engineers was held at the Halifax Hotel at ten o'clock, at which the Secretary, Dr. R. W. Raymond, presided and submitted the following papers by title :—

"Signal Device for Mines," by Chas. S. Herwig, Virginia, Minn.

"The Oil Bearing Shales of the Coast of Brazil," by Prof. J. C. Branner, Stanford University, California.

"A Mining Survey," by J. F. Wilkinson, San Francisco, Cal.

"The Red Ash Colliery Explosion," by William N. Page, Ansted, West Virginia.

"The Hartville (Wyoming) Iron Ore Mine," by Dr. H. M. Chance, Philadelphia, Pa.

"The Ballaratt Indicator," by T. A. Rickard, Denver, Col.

"The Properties of Brass made from Copper containing sub-oxide, with observations of the effect," by Erwin S. Sperry, Bridgeport, Conn.

"The Telluride Ores of Cripple Creek and Kalgoorlie," by T. A. Rickard, Denver, Col.

"The Method for obtaining the Volume of Small Drifts and Working Placers where it is not possible to use the Transit," by Charles S. Herzig, Virginia, Minn.

"The Influence of Silica on the Condition of Carbon in Cast Iron, with Other Notes on Cast Iron," by Prof. H. M. Howe, New York City.

"Biograghraphical Notes of H. B. C. Nitze," by H. A. J. Wilkins, New York City.

"Deep Level Shafts on the Rand and a Method of Working the Greatest Amount of Deep Level Mines with the Fewest Possible Shafts," by Thomas H. Leggett, Cape Town, South Africa.

"Pyritic Smelting in the Black Hills," by Prof. Franklin R. Carpenter, Denver, Col.

"Investigations on Magnetic Fields, with reference to Magnetic Ore Concentration," by Walter R. Crane, Litchfield, Conn.

"International Specifications and Methods of Testing Iron and Steel from an American Engineer's Standpoint," by William R. Webster, Philadelphia, Pa.

"The Micro-Structure and Physical Properties of Cast Iron as affected by Heat Treatment," by A. T. Child, Perth Amboy, N.J.

"Experiments regarding the Influence of Silica on the Loss of Silver in Scorification," by Lester Strass, New York City.

"The Testing of Winding Ropes in the Province of Anhalt, Germany," by Frank H. Probert, Anhalt, Germany.

"Notes on the Compressed Haulage Plant at No. 6 Colliery of the Susquehanna Coal Company, Glen Lyon, Pennsylvania," by J. H. Bowden, Wilkesbarre, Pa.

"Notes on the Methods for Setting Out the Astronomical Meridian in connection with Surveying Operations," by H. D. Hoshold, Buenos Ayres, South America.

"Some Points in the Evolution of Mine Surveying Instruments," by Benjamin Smith Lyman, Philadelphia, Pa.

"The Colorimetric Assay of Copper," by J. Audley Smith, Clifton, Arizona.

"The Protection of Blast Furnace Linings," by S. S. Hartrauft, Buffalo, N.Y.

"Coal Outcrops," by Charles Catlett, Staunton, Va.

"Notes on the Geology of Cochis County, Arizona," by E. T. Dumble, Houston, Texas.

DEEP LEVEL SHAFTS ON THE RAND.

Dr. RAYMOND presented a brief summary of the nature of several of the papers. In connection with Mr. Leggett's paper on "Deep Level Shafts on the Rand and a Method of Working the Greatest Amount of Deep Level Mines with the fewest possible Shafts," Dr. Raymond said that there has been on the Rand a very remarkable development of deep vertical shafts; in fact, there was no mining country in the world so young in its development which has produced such a number of deep shafts. In his paper Mr. Leggett outlined a plan to reach gold bearing deposits to a depth of from three to five thousand feet. The deepest shaft yet sunk in the Rand was 4,464 feet, and Dr. Raymond did not suppose it was any deeper because the

Photo of a party of American and Canadian Mining Engineers taken at Dominion No. IV Colliery, Cape Breton, August, 1900, during excursion of The Canadian Mining Institute, August, 1900.

Boers did not do any of that kind of work. However, he did not think that we have ever had before any miners starting a shaft and going down nearly 4,500 feet throughout barren rock on the expectation of striking a mine. The general grade of the ore of the Rand and South Africa was low grade, and that was why it took American engineers who understood this kind of work to go in and work these mines. Give an American engineer a large mass of low grade material and he will take a small margin of profit and make money. He also remarked that there was only one bed on the Rand of three or four parallel zones carrying gold. Dr. Raymond added : "You may have noticed in June in the papers of South Africa that President Kruger had brought into the Volksraad a proposition to sell the Government deep-mining rights. It was probably a proposition to have all these outside properties put up for sale by auction. There was a tremendous row in the Volksraad, and he was accused of wanting to put the property up at auction so as to have it sold to a member of his own family. President Kruger said they wanted money, but he was asked how it was that he before stated that he had plenty of money to carry on the war. However, the proposal was thrown out and the Volksraad adjourned. President Kruger then issued advertisements offering the properties at auction, and the sale was set for July, but the British were dangerously near, and it was postponed until August, and now likely indefinitely."

METHODS OF TESTING CAST IRON.

In connection with Mr. Webster's paper on International Specifications and methods of testing cast iron, DR. RAYMOND said: "I hope we shall be able to contribute, as the Institute did before, a good deal to the discussion on the methods of testing. The committee of the International Association have taken up special lines and prepared special specifications. This interests you gentlemen in Canada just as much as it does us in the United States. The whole continent is going to be called on to export iron and steel, and I hope not only crude iron or ingot steel, but manufactured iron and steel in structural forms and in castings, and we have got to be ready to meet the specifications of other countries, or we may find ourselves crowded out and our specifications thrown out, although we may have the better article. The object of the Congress which has just finished in Paris is to try and negotiate with the structural engineers of both continents, with a view of getting a uniformity of specifications. We are the ones that stand to win with such a form as that, because while we may adopt some of theirs, we believe that they will come very nearly to our specifications as the best. We will command the English market by reason of our raw material and abundant production and native skill. But the radical point is that we are not going to get the foreign market unless we begin to manufacture by metric scales, and the sooner our manufacturers find out that the dimensions in use by us should be to some extent adapted to the measures in use throughout the world the better. That one thing will prevent the chance of selling a machine. The greatest invention of modern times—the one that has the greatest

effect upon the commercial development of the world—was not the telephone, the steam engine or the utilization of electrical power, but the idea of making replicate parts. Only the other day I had an experience where a friend of mine went over to take charge of a bankrupt concern in Germany. They had everything in their favor, and they had every reason to succeed, and I wondered at the failure. I asked my friend what ailed it, and he replied that there was only one thing that ailed their engineer, he wanted to manufacture improvements. They sent one of their electric trolleys and electric motors down to South America, and they had to couple these to other machinery, and in order to do so they had to make new patterns in order to get out the pieces. The mere lack of uniformity killed that industry. He did not know that it was better to go on and manufacture an old type than to make improvements which put on the side track all the machines he had made."

Regarding Mr. Bowden's paper on Compressed Air Haulage on No. 6 Colliery of the Susquehanna Coal Company, DR. RAYMOND said: "There has been a great controversy going on between electrical power and compressed air. The question is not going to be answered in a hurry, and it will be well for both parties to keep well up. There is a great deal to be said in favor of electricity as being cheaper. We saw at Sherbrooke the other day a crane run by compressed air. Mr. Lewis was running everything by compressed air and he being interested in compressed air would not have electricity around his place. You cannot get around the fact that electricity is dangerous, and a fellow sleeps better nights without it, but we would sacrifice our sleep better if it could be proved that electricity is cheaper, We have some excellent reports on electrical haulage, and now we have one on compressed air haulage which shows remarkable controversy."

TESTING WIRE ROPES.

There was an informal discussion on Mr. Frank H. Probert's paper on the testing of winding ropes in Germany, particularly as concerned the fact developed by frequent tests of such ropes by the author of the paper, that they always lost tensile strength at the first period of use and subsequently increased in strength, a phenomena which was considered very interesting and very difficult to explain.

MR. HORACE SEE: We have none of the conditions that exist on the winding drum. Our wire rope is put out over the rigging where it always remains a straight pull. One thing suggests itself to me in the matter before us, and that is that the test pieces were taken from one end of the rope, so that the question arises whether the same phenomena would present itself if the pieces were cut at the ends where the vibrations would be most intense and have a tendency to affect the material most seriously. It occurs to me, and I think this is shown in fact, that the strength will improve with each succeeding test piece, the last being furthest removed from the end which sustained the final pull. As far as our experience is concerned I cannot say very much about the action on a winding drum, but I would like to know something about testing a rope where the pull is a straight one. We have had

on shipboard a wire rope which is affected from the outside, and we are frequently called upon by captains who say that its state is dangerous because it has been in a certain time. All that we can judge by is the outside appearance.

MR. WILLIAM KELLY: This shows that this paper is exceedingly important and interesting, because it presents new features of appliances to which we daily trust our lives and the lives of others. There are two points mentioned in the resume which I hope may be put in the paper: One is the question of the comparative advantages of ropes of different materials as crucible steel ropes, and the question occurred to me that the tests for these different kinds of rope would have to be of a different nature, and the test that would be suitable for the crucible steel rope might condemn the plough steel rope. The other is in regard to the method of attaching the rope to the cage. There are two principal systems in use in our mining regions, one by socket and one by clamp. The practice varies in different localities, and I have never seen any test of these points, and we have been obliged to adopt one or the other as its advantages have appeared to us from general considerations, but it would be exceedingly valuable if we could have some tests upon which we could base our reasons for adoption.

DR. RAYMOND: The paper intimates that the method there used is spliced. Our experience shows that our wire ropes do not fail for the loss of tensile strength in the strand, but they fail because in bending on the drum the wires in the strand seesaw, and it breaks because the ends turn up. There is no question but that we have lots of rope lying around our mines and collieries that ought to be thrown out on account of defects of that kind, the breaking of a single strand. Mr. Probert says that they have made separate tests of each strand and of each wire requisite, because they found that in a great many ropes which, in the aggregate, stood the tensile test as a whole got that strength out of special strands in the rope that were especially strong, and that other strands were weak. Of course that will not do, and that is the reason of the testing of the special strands. Has anybody come across such a phenomenon as that of a rope in use recovering strength, losing it and then recovering it, and if so, what theory would he suggest? Mr. Gee's suggestion is that the phenomenon did not occur in the middle of the rope. I would like to know what became of the end?

DR. GILPIN: We never had any experience in testing the strands or the rope as a whole. In fact, the ropes have been made by the most improved makers and then discarded as soon as the rope gave way, or became weakened. They gave an average life for the rope, and then when it was used so many months it was thrown aside. I would imagine that the experiment would be most interesting if made on the rope next the cage. So far as I know, no such test has been made here, The principal causes of the destruction of our ropes here are rust and acid water. We have instances of the latter.

DR. RAYMOND: Have there been any Lang Lay ropes, or the Elliott Lay opes used, and how do they stand?

DR. GILPIN: Sometimes there have been complaints of their being a little inclined to twist.

DR. RAYMOND: We never found that.

DR. GILPIN: With these ropes it has been found that if a wire broke it makes a much worse tangle than the other kind.

DR. RAYMOND—You believe the Lang Lay the best?

DR. GILPIN—Yes.

DR. RAYMOND—The Elliott rope is different. It is steel to the centre.

MR. SEE—It has a steel centre?

DR. RAYMOND—Principally steel. The breaking of a strand does not let the rope out but only weakens it to that section, that is all. A rope that is steel to the centre will stand a much larger strain than the mere hemp centre.

DR. GILPIN—These ropes have been used here, and after being used for some time they apparently diminish, the effect being as if the wire were elastic.

THE DEPOSITION OF ORES.

DR. RAYMOND—I have with me some copies of a very important paper by Prof. R. C. Van Hise, of Madison, Wis., on "Some Principles Controlling the Deposition of Ores," and which is published by permission of the Director of the United States Geological Survey, and if any of you desire a copy I shall be glad to provide you with it. This paper is going to make a noise around the world, and it comes nearer to furnishing a satisfactory general theory on that subject than anything I am acquainted with in the literature of ore deposits. Together with several other papers on branches of the same subject read at the Washington meeting in February, it will throw a great deal of light upon a subject that has never been furnished by scientific studies, and we propose to publish them in a separate volume outside of our Transactions, so that it can be made available to persons who are not members. It will probably be a volume of several hundred pages, containing the famous treatises of the late Prof. Posepny, this paper of Prof. Van Hise's, of the University of Wisconsin, and papers by S. F. Emmens, Walter H. Weed, and Waldemar Lindgren, of the United States Geological Survey.

GOLD MINING IN NOVA SCOTIA.

MR. GEORGE W. STUART, Mining Engineer, of Truro, was then introduced, and requested to address the meeting on gold mining in Nova Scotia. He said that perhaps the lack of cultivation of their wonderful resources was due to their own lethargy; that while the other Canadian provinces were not slow in booming their resources, no such charge against the Provincial Government of Nova Scotia could be sustained, as they concealed with a quiet modesty such information for publication of geological and productive facts as would without embellishment ensure an influx of knowledge and capital to their shores that would reap a reward for such essentials as would equal that of any other part of the world. Mr. Stuart then went

into a brief history of gold mining in Nova Scotia from its inception in 1860 to the present day, during which he said there were in the vicinity of 5,000 square miles of auriferous formation in the country, after deducting the intrusive and sterile rocks. Mr. Stuart dwelt to some extent in a scientific manner on the structural formation of the gold measures, showing a most intimate knowledge of the wonderful and rather unique formation containing the gold bearing leads in this section of the country. He made certain comparisons with the district of Bendigo, Australia, showing conclusively a more permanent formation in Nova Scotia. He stated that while the small veins from a few inches to 30 inches in thickness yielded marvelously rich ore, in some cases as high as $4,000 per ton, yet notwithstanding such marvelous richness, the inordinate search for these small veins had, in his opinion, done much towards injuring the mining interests of the country, because of the fact that much low grade ore had been frequently overlooked and abandoned, of which there were many yielding from $1 to $7 per ton, and could be worked under favorable circumstances not to exceed $1.20 per ton. He gave several instances of practical results on such belts now being worked with reasonable capital and modern machinery, showing profits as high as from 50 per cent. to 90 per cent. per annum on the total capital. Several instances were given of the present operations in the province, of mines that had been abandoned for many years because of the fact that poor zones of insignificant extent had been encountered by the old operators, and which now, after lying idle for 15 or 20 years, had been taken up by capitalists and were being operated with most satisfactory profits. Among others the barrel or quartz mine of East Waverley, ten miles from the city of Halifax, was referred to, and as they were going to visit this mine on the following day, he would say for their information that this lead was one of a series of saddle reefs proved to exist to great depth by the use of diamond drill. The lead, which has at present some 150,000 tons of ore in sight ready for stoping, is perhaps one of the most interesting quartz veins known. In order to show the confidence the present owners—an American company—have in this mine, it may be mentioned that a plant is now about completed comprising a 60-stamp mill, with all the other necessary appliances, including a 16-drill air compressor. The plant, apart from that of the Brookfield Mining Company's plant in the County of Queens, is perhaps the most perfect and extensive in the province. This mine and mill are operated by water power, and Mr. Stuart explained that almost all the mines in the province could be operated by water power, either direct or by electricity generated by steam. There were some forty odd districts in the province where more or less gold mining had been done. Mr. Stuart also gave a list of the best known districts, and also the cost of fuel, labor and supplies, including machinery. The labor, which was the best that was procurable in any country, ranged from $1.20 to $1.50 per day of ten hours. Timber, both milled and round, ranged from $6.00 to $11.00 per thousand, and the price of machinery of all kinds, which was now manufactured in the province, was as cheap if not cheaper than could be procured in any other part of the world.

DR. RAYMOND: The indications which Mr. Stuart has given of a revival of gold mining in this province and to a greater depth is parallel with what has been occurring in California, where with energy and modern appliances they are treating rock that was formerly thrown away. I remember a couple of years ago enquiring as to the cost of mining and milling in California, and I found they were able to extract ore from the hard quartz vein 2,500 feet from the surface, and take it up to the surface and treat the concentrates for about $2.60 per ton, of which $1.25 went for mining. There, as in this case, they had the advantage of water power, and I am sure that the abundance of water power will be an enormous factor in the prosperity of a mining region located as is this Province of Nova Scotia.

DR. GILPIN: I do not know that I can add very much to what Mr. Stuart has said, nor would I like to attempt any criticism of his paper without having gone over it first. There is one point which he neglected to refer to which is of some little interest. He spoke of the action following upon the completion of the quartz veins. As a matter of fact, the quartz or auriferous formation and the Devonian were broken into by the granite, which is an obtrusive rock at the end of the Devonian or the beginning of the carboniferous. The effects of the denudation as seen to-day are due not only to the recent glacial action but also to the geological. I noticed that Dr. Raymond referred to the water power as one item in the lowness of the expense of gold mining in Nova Scotia, but as a matter of fact all the properties which Mr. Stuart referred to as giving examples of cost of mining are driven by steam.

MR. STUART: Yes,

DR. RAYMOND: Is not the Waverly run by water power?

DR. GILPIN: That is water power, but that mine is not in a position to afford a statement as to the cost.

MR. STUART: No.

DR. RAYMOND: With steam at $1.50 a cord for wood.

DR. GILPIN: I think Mr. Stuart will have to pay more for his coal.

MR. STUART: $1.70 at the wharf, run of the mine.

DR. GILPIN: We paid more than that.

MR. STUART: I would be glad to be corrected.

DR. GILPIN: The gold mining industry of Nova Scotia has in the past consisted almost entirely of operations in the small gold-bearing veins. Many of these small veins were not suitable for the operation of companies when they were suitable for small local syndicates, because it was found that after $150,000 or $200,000 had been taken out the pay-streak ceased, but there have been veins of moderate size which have been worked very profitably by companies for a long time. I think the best results are to be looked for in the low grade belts. They are undoubtedly the most certain, and it is along these lines, I think, that the greatest development is to be made. Our mining facilities are very good. We have no snow or frost or heat that interferes with mining, winter or summer. Of course, we cannot prospect in winter,

because the ground is frozen, but all our mining is carried on in winter as in the summer.

DR. RAYMOND: Has the recent glacial denudation taken place before or after the completion of the veins?

DR. GILPIN: After.

DR. RAYMOND: Then in that case you began the work in this province for a thousand feet below the original surface when the range was formed?

DR. GILPIN: Yes, but as a matter of fact, we have mines that have been opened on the entire thickness forming the original gold-bearing horizon.

DR. RAYMOND: How deep have your high exposures been worked? And what is the aggregate height above the sea that the gold veins are exposed?

DR. GILPIN: Mount Uniacke is about 600 feet above the sea, and veins have been worked there to a depth of 350 feet.

DR. RAYMOND: I only wish to bring out this point to emphasize what Vancotta said. It is absurd to talk about veins giving out when they were originally five or six thousand feet higher than they are to-day. You start five or six thousand feet below and then you wonder whether it is going to give out. For instance, in California, the mother lode runs with it, and it is crossed by innumerable canyons. We run across the vein on the top of the mountain, and then run across the same vein a thousand feet further down. The veins in the canyon were poor and on the high mountains rich, and that made prospectors feel that they gave out. It is only within the last few years that we have found bed-rock at a depth of a thousand feet, and now they mine at a depth of 5,000 feet.

DR. GILPIN—I notice that in some of the districts Mr. Stuart mentioned only mispickel mineral accompanying the gold, but I presume that that was the principal.

MR. STUART—Yes.

MR. WILLIAM S. EDWARDS—In California the experience of our miners had been that after going down five or six hundred feet there did occur a barren zone and that continued 400 or 600 feet further down, and when that barren zone was reached the men of the mine ceased work. But latterly they have tried it again and they have struck pay ore still further down and that is what they are working on now, and as far as I know they have not reached the bottom of that pay zone yet. They have reached down some 2,000 feet, and they have 1,200 feet of continuous pay ore in depth.

DR. RAYMOND—In olden times when they went down to $5.00 a ton they could not work it at such a depth.

MR. EDWARDS—They can take it out from $2.00 to $3.00 a ton.

DR. RAYMOND—I suppose they take out $3.00 stuff rather than none.

MR. EDWARDS—There was one man out our way who only got 69 cents for years and years and still they worked it.

MR. KELLY--I would like to ask whether the developments in the gold mines here lead them most to resemble the deposits of Bendigo in Australia of those of South Africa. The illustrations in the paper rather suggested South Africa, and yet I think it is more generally supposed that they resemble Bendigo.

MR. STUART--The mines I referred to compare with Bendigo rather than South Africa.

DR. RAYMOND—It is at Bendigo where saddle reefs occur and these are saddle reefs.

MR. STUART—The saddle reefs in Bendigo are rather numerous. There are over a dozen now in 3,000 feet, the saddles occuring every 100 feet or so, but the legs grow narrower as depth is attained, while here the legs grow thicker in depth.

MR. KELLY—It is the same kind of deposit as at Johannesburg. The only resemblance to Bendigo is in the seams being bent over an anticlinal. The fact that there are two or three or more deposlts that have been pierced by going down across the strata is the same as Dr. Raymond mentioned at Johannesburg. The only thing that suggests Bendigo is this anticlinal fold at the other end, a description going to show that the seam is continuous.

DR. RAYMOND—There is a radical difference between this and South Africa from the fact that that is a conglomerate rock and this is an intrusive granite. However, I do not feel that the analogy is perfect with Bendigo, and I agree with Mr. Kelly on that one point. The very nature of the Bendigo saddle reefs requires that it should peter out and this does not.

DR. RAYMOND then announced that the next meeting would probably be held in Richmond, Va., and the meeting after that in Mexico, where they had intended going last year, but owing to the outbreak of the war had decided not to do so.

The session then adjourned.

MONDAY AFTERNOON—HARBOUR EXCURSION.

On Monday afternoon, by the courtesy of the Mining Society of Nova Scotia, the members were entertained to an excursion in Halifax harbour, on board the commodious steamer "Chebucto," and as the party proceeded down the harbour it was seen that both islands and mainland actually bristled with forts and guns, prominent among which was the York Redoubt, which occupies a lofty eminence and is one of the strongest forts in the world. The splendid view of the fort from the steamer was of particular interest to the American visitors. Forts of minor importance could be seen on McNab's Island, where is situated the military rifle ranges, on St. George's Island and on the Dartmouth shore, and the citadel directly overlooking the city of Halifax must not be forgotten. The many pretty coves and the scenery along the shore, were the delight of the man with the camera, and as the steamer entered the beautiful North-West Arm, the American visitors were in ecstacies at the panorama spread before them. The picturesque shores on either side make an ideal spot for residential purposes, and on the shore nearest to the city are to be seen many of the

beautiful residences of Halifax's prominent business and professional men. From the North-West Arm the steamer took the party through the Eastern Passage and then around the charming Bedford Basin. Luncheon was served on board the steamer. The visitors were accompanied on this trip by a large number of the leading citizens of Halifax, including her public, business and professional men, many of whom were accompanied by their ladies. Just before landing the whole party were assembled on the upper deck when several addresses were delivered.

MR. B. T. A. BELL, Secretary of the Canadian Mining Institute, addressing the gathering, said—Some of us have thought this an opportune moment to have our friend the Premier, Mr. Murray, address a few words of welcome to our guests the members of the American Institute who are with us today. I will therefore, with your permission, call upon Mr. Libbey, President of our Mining Society, to convene this informal gathering.

MR. W. L. LIBBEY—Ladies and gentlemen, it is with feelings of pleasure that I reflect on the auspicious character of this gathering. In the first place the inception of the whole happy programme of today and of the last ten days was entirely due to Mr. Bell. Since then, under the general auspices of the Canadian Mining Institute and the Mining Society of Nova Scotia we have had the pleasure of entertaining as our guests the members of the American Institute of Mining Engineers, and, characterising them by their title, I think that the definition of the word American should be fully comprehended. It is not the Mining Institute of the United States, but it is the Mining Institute of America. America commences in the frozen icebergs of the North and it extends to where Cape Horn whirls into sleety storms over the meeting waters of the Atlantic and the Pacific, and from the foaming cascades of Newfoundland in the East where the salmon leap and play to the shining sands of the golden gate in the West. But the field of usefulness of this organisation is the world. (Applause). Its work is the building up and making to bloom of the desert places of the earth. (Applause). It is changing the financial and political policy and the racial characteristics of empires. In fact, the work of mining engineers almost redeems the mistakes of missionaries. (Applause). I am here in behalf of the Mining Society of Nova Scotia to say that I believe the results of the introduction of these men of brains, ability, and tireless energy will be written by a man yet unborn. They are the forerunners, the advance agents, of capital. We have shown them resources that they did not dream of. I am with you all in believing that Nova Scotia has the wealth, the natural mineral wealth, to invite the attention of any and all capitalists, and it is a most auspicious occasion for Nova Scotia that this Society is here without any schemes or deceits. We can entertain them as guests, and they can go away with a full knowledge of what we have been doing. I will now ask the Hon. George Murray, Premier of Nova Scotia, to address you. (Applause.)

HON. MR. MURRAY was greeted with the singing of "For he's a jolly good

fellow," as he rose to speak. He said—Mr. President, ladies and gentlemen, I am almost inclined to think that there is one thing upon which we are all agreed this evening, and that is that it is being too pleasantly spent for speech-making. However, I am pleased to say that when it was first announced that the American Institute of Mining Engineers was to visit us, we all felt in this Province that a very great honour was put upon us. I watched with interest the arrangements that were being made, and in that respect I was assisted by the very excellent programme that was prepared, and I want to say right here that that production was very creditable indeed. (Applause). When Mr. Bell undertakes to do anything, he does not do it in any half-hearted way—perhaps you have discovered it. (Applause). I have sometimes thought that Nova Scotians were all boastful, but we think we have some reason to be proud of the Province of Nova Scotia. Perhaps as you gentlemen had opportunities of seeing our coal and our iron there is very little left for me to say anyway. I believe that every good mining engineer believes in seeing rather than hearing, and you have had a splendid opportunity of seeing something of the coal and iron interests of the Province of Nova Scotia. We have confidence in the Nova Scotia Mining Society, and I was very glad to see that the Society had our distinguished visitors in charge. I simply want to say that I was glad to see the statement in the programme published by Mr. Bell that he thought the mining legislation of Nova Scotia was fairly reasonable. (Hear, hear.) You know, mining men criticise legislation, but assisted in the past by the Society we have been enabled to put upon the statute book of this Province such legislation as to make everybody feel, whether English or American, that every dollar of American money is just as safe in the Province of Nova Scotia as a dollar of English money. (Loud applause.) I want to make that statement. Now I hope you are pleased with the entertainment. (Applause.) You have probably a million of our Canadian native born people in your country. I think they have made fairly good citizens. If we cannot get any exchange in any other way for a very large portion of our population we are willing to take your money to develop our mineral resources. You are indebted to us in the past, and I trust this meeting will bring the natural resources of the Province of Nova Scotia more to your attention than in the past. I thank you for this visit, and I hope you will be sufficiently pleased with it, so that in a few years we may expect a return of this visit. (Applause.)

Dr. R. W. RAYMOND—Mr. President, ladies and gentlemen, as Secretary of the American Institute of Mining Engineers, and as representing that Society because of the absence of our beloved president, Dr. Douglas—I am glad he is not here because he was born in Canada, and he could not say with the same force as it could be said by one who was born south of the line what I propose to say now—I am sure that I speak the sentiment of every member of the American Institute when I express the delight with which we have visited this fair province, which we are so soon and so regretfully to leave. To those of us who were here a dozen years ago,

there is a great perceptible change. There is a spirit of energy and activity, all stimulated by prosperity, a golden future and active present, which we could not then have seen. It is due not only to the natural progress which this noble continent has undergone, but to what I humbly believe to be the fact, to such societies as ours, both in Canada and the United States, in welding together the professions of mining engineering and metallurgy, and the bringing to bear upon all our mineral resources the scientific theory and business ability which they require. But it is due also to the intelligent and fostering care of the government, not only of the Dominion but of this province, during the last dozen years. If you will allow me to say a word right here that will be no news at all to Canada, but may be information to our own members, that when this series of British Colonies was welded into the Dominion of Canada, and when Nova Scotia gave up its independence and became a sovereign state in that confederacy, this province was stripped of its sources of income and in return for it received an annual grant of $400,000—that used to be a large amount but it is so no longer—and within that very limited period, and if I am not mistaken without any other recourse except direct taxation, which none of us like and which has not been resorted to as yet—with regard to that direct taxation, as a theoretical proposition is perfect, but put into practice every mother's son of us kicks—this province has tried to do what could be done, and it has not been measured with what could be done with limited means or unlimited advertizing and brag and swindling, but what could be done by honest labor and economy in developing its mineral resources. I for one believe it has been done wisely and well, and I am very happy to see that in the list of measures which the government of this province has favored and has undertaken, there has been not only a liberal and just mining law, but also a very intelligent and wise forecast concerning that great element of success, viz., scientific and technical training. (Applause.) Already there has been established in connection with the Truro Normal School a course of scientific training as an evidence of what the government hope to do. And I am informed that the governments of the Lower Provinces are already consulting earnestly with a view of establishing somewhere in this region such an institution to include mining engineers and metallurgists, as Sir William Macdonald's great beneficence to McGill University has enabled them to do, and what we have done during the last 25 or 30 years in the States, to establish thorough schools, so that our sons are no longer obliged to go abroad to learn what they could learn at home. We shall be exporting professors to Europe before long. (Hear, hear.) I am not one to disparage such interchanges as these, for the more of the world a man has seen the better citizen he makes at home; nevertheless the shame no longer rests upon us that there are things learned abroad that cannot be learned at home, it has been removed from us. And it is being done in Nova Scotia, and the time will come when they will no longer require to go abroad and learn in foreign schools. I make this cordial acknowledgment therefore of what the government of Nova Scotia has done with energy, patriotism and liberality. I do not understand the difference between a liberal Conservative and a conservative

Liberal. (Laughter.) I read Sir Charles Tupper's speech on the other side, and I thought it was a great speech, but after all it seems very clear on this side of the line that both political parties have at heart the welfare of their country, but they do not go further than that. When it comes to the question of the prosperity of Canada they join hands—the free traders do not insist on killing industry, and the protectionists do not throttle importation. (Applause.) We are very much delighted to see this harbor of Halifax. This is the best fortified city on the coast of this continent, and it seems to me a very interesting fact that this city has been so well fortified that no gun was ever fired in anger over the waters in this harbor. Annapolis has been taken I don't know how many times, but you fortify Halifax and there has been peace always. I would that all the fortifications of the world would have the same effect. (Applause.) We are fortifying now and trying to keep up even with Halifax, and I hope when our fortifications are built that the grass will grow over them as it does on yours, and that the strongest of our batteries will be, as the strongest of yours, those where the guns are entirely invisible. (Applause.) But, ladies and gentlemen, I cannot sit down without mentioning one other reason which draws us closely together to-night—I mean the prayer I heard yesterday morning in your garrison church, with which I joined with all my heart, "God Save the Queen." (Loud applause.) That dear and venerable lady in whose firm and wise and tender hand more than any other mortal hand this day rests the fate of civilization and christianity. (Renewed applause.) God bless her. (Loud applause.) If she had her way there would not be a drop of blood flowing this day, nor a tear falling from the orphan or widow in all the world. God bless her again, because she knew that there were things worse than blood or tears; that national honor had to be maintained; that the nation's sons had to be protected; that in South Africa or in North Asia, and in common with the other powers of the world, it was her place and the place of her great empire to stand foremost in the hour and in the place of peril. (Applause.) Oh, my friends, none of us from the United States are going to forget this day, nor any day to come, how our sons and your sons have stood shoulder to shoulder, hand to hand, heart to heart, and upheld by that blood which is thicker than water, the standards of both our realms. I do not want the United States to annex Canada, but I won't let Canada annex the United States. There is a union that is better than that. We want no union that wipes out either of these glorious flags. Our colors are the same—red, white and blue—our national anthem is the same, if we sing them as you do, so that no fellow can find out what the words are—

My country 'tis of her,
Long may she reign.

(Laughter). But in these greater aims and higher developments and nobler achievements in which we are at one, there is no need to talk of annexation. Annexation is putting two things together and trying to make them stick. Fusion brings them together—we are fused already. (Loud applause.)

MR. B. T. A. BELL: Mr. President, ladies and gentlemen: After the characteristically brilliant speech of our friend, Dr. Raymond, any crude and ill-digested observations of mine are superfluous, but as an officer of the Canadian Mining Institute, an organization representing very thoroughly all classes of the mining profession in Canada, I would be remiss to my duty did I not express, on behalf of the members, our great appreciation of the courtesies and kindnesses which have been showered upon us, and upon our guests, the members of the American Institute, since we entered this glorious old Province of Nova Scotia. We trust this visit of our American confreres will enable them to appreciate more correctly the great resources and possibilities of this section of the Dominion. They have met in Canada several times, and we trust before very long we shall have the pleasure of seeing them with us again. It is just by such practical meetings as this that we can best promote the development of our resources.

On behalf of our Institute, I desire to express to the President and members of the Mining Society, and in this connection more particularly to my friend, Mr. Harry Wylde, the Secretary—who has been indefatigable in his exertions on our behalf—our sincere and grateful acknowledgment of what has been done for us and for our guests. (Applause).

The whole party returned to the city thoroughly delighted with their outing in Halifax Harbor.

TUESDAY—WAVERLEY GOLD MINES.

The last function of the visit at Halifax was the visit to the gold mines of Waverley, on Tuesday. The party left by special train shortly after breakfast. The property visited was that of the Waverley Gold Mining Company, known locally as the "Tunnel" mine. The company, which by the way included the Hon. W. S. Fielding, M.P., the Finance Minister, was escorted to the works by Mr. D. C. Hood, the Secretary, and Mr. J. G. McNulty, the manager. As we did not go to the mine, and the officers of the company have refused to give us any information for publication concerning its organisation or equipment, we must be content with reproducing our stenographer's notes of the visit. At two o'clock, after inspecting the mine and mill, which we understand is water driven, 40 stamps in place, with accommodation for 70 more, the visitors were entertained to a sumptuous luncheon, served in a large tent which had been erected on the beautiful lake shore at the foot of Laidlaw's hill, where the mine is operated.

At the request of Mr. D. C. Hood, Mr. James F. Lewis, of Sherbrooke, a member of the Council of the Canadian Mining Institute, and at one time an officer of the American Institute, presided.

The toasts of "The Queen" and "The President of the United States" having been loyally honored, the chairman called upon Dr. Douglas, President of the American Institute.

DR. DOUGLAS: Mr. Chairman, ladies and gentlemen, no words can express our thanks, and therefore you must accept my assurance that it is absolutely the case. I am glad to see that Mr. Bell had on the last page of the handsome Souvenir Programme, of which we have all received a copy, two flags—on one side the flag of the Union, and on the other the flag of Great Britain. I cannot help thinking that such meetings as this, which is drawing to a close, does tend to draw into one the American continent. In that respect we are all heartily in favor of the Munroe doctrine. The American Institute goes a little further than that, and is willing to embrace Mexico within its arms. Before very long we expect to meet you south of the United States, and to express there that very feeling of co-fraternity—we cannot call it consanguinity—that the American Institute expresses to you. There is this in our mining and our milling, that no possible jar can possibly mar the enjoyment of these visits. Whatever other differences there may be in matters of politics or in matters of religion, we are one in this. We are all solid and still bent upon developing the natural resources, not only of our own continent, but as far as nations will follow us, the resources of the world; and in that aim and object we have no limited liability company with watered and unwatered stock. It must be admitted that occasionally we are inclined to be a little watered in our stock, and inclined to go beyond strictly scientific facts, but at the same time science is science, and science is open to the world, and every scientist is willing to tell and to teach all he knows, and to indicate freely and thoroughly all his experience to those who will gather to hear him, and these meetings of ours, which take in one section after another of the continent, undoubtedly do bind us together with the closest ties of friendship verging almost into love. It is really with more than feelings of kindness towards you—I will call myself in the meantime American—that we Americans wish you good-bye, and wish you God-speed in the work you are carrying on in this Providce, and which will have such a magnificent end. It is no mere hap-hazard that you have taken us last to the first industry, gold, and first of all to your newest great industry in iron and steel, because it is this last which always seemed first, and it is the science which iron and steel require which I think has stimulated you to put your gold industry on a more scientific basis than it formerly was. We cannot any of us doubt that the gold interest of Nova Scotia will make more progress in the future than it has ever done in the past. In its early days it was a very hap-hazard interest. No one tried to dip down into the causes of things. Here on this hill there were a great many little companies stripping off the quartz, and they believed that when they had stripped it they had taken the very roots out of the hill. To-day one company is working it with science and skill, and with capital behind it, and bringing about the results which you have seen—results which will not only redound to the prosperity of Nova Scotia, but it will likewise fill the treasury and the pockets of those interested in the company with the gold which they are extracting. It is only of late, in fact, whether here or elsewhere, that these problems are being studied with anything like scientific accuracy,

and what you see to-day—the revival of an almost extinct industry—has occurred elsewhere. Last year we visited the mother lode in California. There we saw the marvelous ore deposit which in the early days enriched California, and which had fallen into decadence, mines closed and everything gone to wreck and ruin, the mother lode supposed to have been exhausted. But better machinery, more skill and higher metallurgical science was brought to bear upon it, and the prosperity of the mother lode was never more assured than it is to-day. Exactly the same thing has happened with you. Thirty or forty years ago these hills were in a crude state yielding much gold; the rich surface ores were exhausted, and with their exhaustion were supposed to be exhausted all they contained; but science has been brought to bear upon it, and the peculiar character of your ore deposit and the geology of the district has been studied, and the result is what we see to-day. Very often we hear on both sides of the line that our geological surveys do not sufficiently deal with purely technical subjects; that they are content to view only the scientific side, instead of the practical side of their work. I think that the geological surveys are right, and I think that here we have proof of it. Had it not been for the careful study of the geological formation of this part of the country such work as we see upon this vast anticlinal would never have been undertaken. It is only by the Geological Survey of Canada combining together and co-relating facts that their officers, by their wide experience, are able to draw conclusions by which you practical people have been able to work a 40-stamp battery, where formerly a 5-stamp battery would have sufficed, and project a mill of 80-stamps. I say this because I feel that many of the criticisms that have been made on both sides of the line of the work of our geological surveys are not correct, and such institutions as we see to day is a confirmation of the course they have pursued. I am drifting far away from what I intended to say, and that is to reiterate the hearty thanks of the American Institute to the societies of which we primarily are the guests, and to every lady and gentleman, and every institution which has labored so heartily to make our visit not only pleasant in the highest degree, but profitable to a still higher one. (Applause.)

THE CHAIRMAN: There is one thing that I think we have fully demonstrated during our trip, and that is our capacity for a jolly good time, for great eating and drinking. We have listened to some talk also, but only by a few of our members, and it is generally understood that when Dr. Douglas talks and Dr. Raymond talks that they have been studying for it, and now I want to hear from three or four others. I am going to call upon a gentleman largely connected with railroads in Pennsylvania to tell us what he thinks of the Dominion of Canada. I will now ask Mr. George F. Baer to address you.

MR. BAER—Mr. Chairman, ladies and gentlemen, there is an unwritten law in the American Institute of Mining Engineers whereby we are required to elect orators to office so that those of the rank and file shall never be called upon to make a speech, and I assure you that if I were not in a strange land and under orders from

a superior I would hesitate to undertake to speak, in view of the fact that it is contrary to the custom of the American Institute, but I feel that I would be wanting in full respect to you and do violence to my own sense of obligation if I hesitated to add a few words to the many that have been spoken in favor of the impression, the agreeable impression, that has been upon all of our visit to your very fine country. Very many of us know very little of Nova Scotia and of Canada. It is true we have read from time to time of the grand resources of the Canadian settlements, and of the siege of Louisburg, and the stories of cowboys as told by our own Longfellow, and we have read novels that tell us of the Seats of the Mighty, we have heard of the fine fish stories told us by Americans returning from the Dominion, so that our impression of Canada has been an agreeable one, but still it was an impression that was made upon us from afar off. We had no adequate conception that we would meet up here a generous, whole-souled people so thoroughly American and so like ourselves, and from the time we left our homes we have never known when we crossed the line, nor have we been able to distinguish the Celt, the Gaelic, the Anglo-Saxon, the Teuton or the Canadian from the true-hearted American. (Applause.) Now we have visited some portions of your land and we have seen with what earnestness you have entered upon the development of your material resources. I sometimes think that that old command given at the beginning of man, that he must subdue the earth, has been misinterpreted for centuries, and that it consisted in an attempt to subdue his fellowman, and it is only in modern times that the subjugation of the earth means the bringing of all its hidden forces under subjugation. This we are accomplishing in our own age; through heat and electricity and all the countless powers that man has developed we are subduing the earth. Deep down in the mines we take our power and compel it to unearth her hidden treasures, so that to-day more than ever on land and sea man is asserting his true dominion and carrying out his original command that we should subdue the earth and replenish it. This peaceful subjugation you are undertaking, and we can only hope, as we have no doubt, that it will be successful in every way. May I not say that the great progress that has been made in the earth in the last century has been made by men of our race. I do not mean to use that common phrase, the Anglo-Saxon, which to me is misleading, because I am of pure Teutonic blood, but I mean that Irish, Scotch, German and English, combining together and mingling together on this continent, have developed a system of government that is just and true, that has made itself felt all over the earth, not merely a government in name, but republics, for we have long since learned to know that the form of things is nothing, it is the substance that tells, and here in Canada under your own system of small States with a Queen as your central power you are as free as we are under a system of small republics under one great republic with a President to rule over us. (Applause.) So that the outward form of things is nothing. Wherever there is a pure government secured to men in their life and property and in the pursuit of happiness, there you have the true system, call it by what name you please. I have sometimes

thought that the suggestion of Max Muller was true that it was not race, but it was language which unite a people. Philologists tell us that centuries and centuries ago upon the high table lands of Asia there dwelt a people speaking a common language and that in the course of years they wandered westward and southward and created the great commonwealth of Greece and the great Empires of Rome, and gave a high order of civilization to the world, and that in the course of years and years they forgot the common language, so that when they met they could not understand each other. I have sometimes thought that here on the American continent were to be reunited all the scattering and wandering tribes, and that here men coming from every race and speaking every tongue under the heavens as in the beginning before the dispersious they were united, and that the common tongue they would speak would be English, so that the English-speaking people would be the typical race for all time to come. (Applause.)

THE CHAIRMAN—We have a gentleman from Michigan, and he has also been studying the mines in this section of country as we have, and I am going to call upon Mr. William Kelly, of Vulcan, Mich., to say a few words to us.

MR. KELLY—Mr. Chairman, ladies and gentlemen, I did not know that sitting alongside Mr. Lewis necessitated the making of a speech or I would certainly have got here earlier and chosen one in the far corner. However, being called upon, it seems that the duty is imposed upon me of expressing my thanks—which is undoubtedly the sentiment of all the members of the American Institute of Mining Engineers—for the courtesies that have been extended to us since we joined the party at Quebec, especially to those societies who planned the programme, and to those friends who have so kindly lent their aid. It seemed as if it was almost becoming a contest between the hospitalities that were being extended to us and the physical capacity we had to receive them, but our capacity to appreciate has not reached its limit, and we are carrying away memories that will live forever. (Applause.)

THE CHAIRMAN—The gentleman whom I am now about to call upon is a member of the Canadian Mining Institute, yet he has taken to-day his first initiation in mining, and he has during his daily life so much figuring with finances and that sort of thing that I am going to ask him to talk about plain every day matters, especially his experience in the first lesson he has taken in mining.

HON. W. S. FIELDING, Minister of Finance—Mr. Chairman, ladies and gentlemen, I count myself fortunate in being able, even at this eleventh hour, to participate in a small degree—small only by reason of time—in an excursion which I know has been exceedingly pleasant, and which I would gladly have enjoyed from the beginning had I been able. Our friend across the table thought he was in a strange land. I think if I could suppose myself in a community of Hottentots, but surrounded for a moment by the members of the Institute of Mining Engineers, I should not have imagined myself in a strange land. It has been my good fortune on many occasions to meet the members of the mining societies, both provincial and federal, and share with them—

"That communion of heart and that parley of soul,
Which have lengthened our night and illumined our bowl."

In Halifax, in Sydney and in Montreal many things happened which our friends do not always tell you of. I can recall occasions in the Mining Society of Nova Scotia and the Federated Canadian Mining Institute when I had the opportunity of meeting some of the friends. On the important occasion when the American Mining Institute paid a visit to Canada, I remember the night that we climbed Montreal mountain with an escort of snowshoers, and that when we got to the top of the mountain the President of the Association and myself found that there were higher latitudes, which we occupied for a very few moments (laughter). I do not mind confessing that it was with regret that I saw you go away from Quebec, but I had just returned from Europe, and a stern sense of duty prevented me from joining you just as you turned down to the land of the Blue Nose. A friend of mine once told me never to neglect any fun for the sake of business, and I had that feeling at the time I saw you go away. However, I went up to Ottawa to attend to a little business, and yesterday I caught up with you. You have, I am sure, been welcomed by my friend, the Premier of Nova Scotia, who has spoken on behalf of his Government; if you had arrived at Quebec a little earlier I would have been glad to welcome you on behalf of the Government of the Dominion. I suppose it is a little gratification to know that you have as your president a Canadian. We are a little proud of that. In this connection I am reminded of Pinafore—

"For he might have been a Russian,
A Frenchman, Turk or Prussian,
Or perhaps an A-mer-i-can;
But in spite of all temptation
To belong to another nation,
He remains Can-a-di-an."

(Applause). It is greatly to his credit, but there is something that is a great deal more to your credit. You have by your President proved that you have no nationality in science, because that science is world-wide, and that you are prepared to recognise merit wherever you find it. We are glad to have you come into Canada. You came to Quebec, so full of beauty for the artist and so full of interest to the student of history, and you came down the St. Lawrence into Nova Scotia and Cape Breton. You have seen some of the natural beauty of our country, and I hope you have been most hospitably entertained wherever you went; but if you will not tell anyone I will let you into a little secret, and that is, that we have an eye to business all the same. Was it not your own Mark Twain who said that when his uncle got a big pork contract from his Government he was glad to know that while he served his suffering country he made a nice thing out of it. (Laughter). So we hope that some of you, after you investigate the resources of the country, will come back again and leave some of your money behind you. Some of you have already found permanent investments for your money in the Dominion. We are glad to be able to say that the mineral development of Canada, principally of Nova Scotia, has been largely carried on by our enterprising friends from the United States, and the great industrial enter-

prise which is being built up in Cape Breton today is, first of all, the handiwork of a great and enterprising American who led the way. We hope and trust that this intermingling of men and women from the two countries will always be productive of good results. Living side by side as neighbors we ought to see more of each other. We ought to be good neighbours, and I can imagine nothing more likely to assist us in being so than such visits as this. I trust that your visit to Canada has been productive of both pleasure and profit, and that the knowledge that you have obtained in regard to the resources of Canada may induce many of you to again visit us whenever the opportunity occurs. (Applause).

THE CHAIRMAN: There is one more toast—and we have toasted everybody from Quebec to Glace Bay and back—and that is "The Ladies," who have helped to make our stay so pleasant wherever we have been. I ask you to drink most heartily to the dearest creatures on earth, and will ask Dr. Raymond to reply for them. (Applause.)

DR. RAYMOND: Mr. Chairman, ladies and gentlemen, I think that I have got at last the speech I have been fishing for ever since we came into this fisherman's country. Mr. Lewis said that I have studied a speech. I present the ripe conclusions of about 40 years' study, to say nothing of the earlier years that I find it convenient to forget, and I feel it quite appropriate, as an official representative of the American Institute of Mining Engineers to reply to the toast to the ladies, because it was the one technical society on this continent or of the world, for all I know, which was the first to give a place in the sessions and excursions to the ladies (applause), the first to strike a mortal blow to that surviving monster of barbarism, the stag party. You remember, some of you, the night of that first banquet when we paralyzed the town of Pittsburg 21 years ago by inviting the ladies, and when we found it pleasant, not to drink too much and get under the table, but to enjoy rather the society of the ladies opposite. And we were well repaid, and there never was any cause of complaint. Every man in the American Institute is either a married man, or means to be, or wishes he were; but, on the other hand, let me warn you a little against some of these alleged bachelors who have left their wives at home. Do not be deceived by these gay Lotharios. Our beloved Alexander Holley stood up that night at Pittsburg and spoke the words that rang in our hearts, and spoke about the queens of whom we were the soldiers; how he described the mining engineer ranging through all the earth, facing the dangers of the wild beasts and hostile tribes, facing the tunnel through the mountain, bridging the stream, delving into the earth, risking all, daring all, achieving all; and now, he said, if you follow up this man you will find that the ambition of his life and the secret of his firmness is that at the end of that silver cord somewhere there is a little woman into whose lap he pours all his wealth, at whose feet he lays all his ambition, in whose eyes he seeks all his love, and from whose lips he takes all his reward. Yes, we are the soldiers of the queen; yes, we do work for those whom we love, and we understand how to take health and

strength from them, and they know how to work with and for us. (Applause.) We have got two or three ladies members of the Institute. One of the best mining engineers in California is a woman, and one of the best chemists in Missouri, Miss Rich, of Boston, is a woman, but it is not among these that they show their glory. I for one, having been in orders for the period of a silver wedding, and not very far from a golden one, think it is the happiest condition a man can be in, and I—counting myself one of this Society, one of its founders, and in which I may claim to have exercised some influence as almost continuously holding office in it—am glad that it has put itself so firmly on record on the side of the higher joy, the union and companionship with the daughters of the land, and the fair daughters of this fair land add to its charms of sea and sky such unspeakable attractions of a cordial delicate welcome, these sisters of ours known since yesterday only, to be forgotten never, may take from us the assurance that we shall hold them always in our hearts with gratitude and friendship. Yes, gentlemen, I give you the old toast—men's sisters, sweethearts, and I will not say wives, for our true wives are our sweethearts evermore (applause).

The party then returned to Halifax, and in the evening, at the invitation of the Garden Commissioners, attended a patriotic concert in the Public Gardens at which an address was presented to the brave boys of Halifax who had returned from the seat of war in South Africa, and at which Sir Charles Tupper, Bart., also delivered a patriotic address.

WEDNESDAY—RETURN TO LEVIS.

On Wednesday morning at ten o'olock the special train left Halifax for Levis, Que., amid salvos of cheers and the greatest enthusiasm. The train arrived at Levis at six o'clock on Thursday morning, breaking the record for that run, and after the visiting engineers had spent a portion of the day in Quebec city, they left in the afternoon for their several homes, the American party leaving by special train over the Quebec Central Railway. Thus concluded one of the most successful summer meetings which it has ever been the good fortune of the Canadian Mining Institute to hold.

EN ROUTE FOR NEWFOUNDLAND.

The following members visited Newfoundland: Mr. Walter Wood, Prof. Ladd, Mr. C. S. Hinchman, Dr. Drown, Mr. J. W. Dougherty, Mr. E. L. Wiles, Mr. and Mrs. Wethey, Mr. and Mrs. E. P. Jennings, Mr. and Mrs. Sherrerd, Mr. and Mrs. H. J. Seaman, Mr. and Mrs. Tompkins, Mr. and Mrs. Edwards, Mr. and Mrs. Guildford Smith, Mr. and Mrs. Bonner, Mr. R. B. Ross, Mr. Levi Holbrook, Mr. W. S. Hinchman and two daughters, the Misses Brown, Dr. C. H. Jouet, Mr. Theo. D. Rand, Mr. and Mrs. B. T. A. Bell. A small party of these visited Newfoundland direct from Sydney, rejoining the main party at Halifax before returning to Levis, and the others, numbering close upon forty, left the special train at Truro on their way up. On arrival at North Sydney this party received and accepted an invi-

tation to visit the old Sydney mines on Thursday, as the guests of Mr. R. H. Brown, the manager, and his two charming daughters.

AT OLD SYDNEY MINES OF THE N. S. STEEL CO.

The party drove over from North Sydney to Mr. Brown's delightful residence, about eleven o'clock in the forenoon, being received by the Misses Brown. The ladies spent a delightful morning in Mr. Brown's beautiful gardens, while the men inspected the plant at the colliery. This property has for a great many years been successfully worked by an English company, the General Mining Association, Limited, registered in 1825, but recently it has been sold out, and is now being worked by the Nova Scotia Steel Company, Limited, being part of this company's comprehensive scheme to establish a large steel works on similar lines to that of the Dominion Iron and Steel Company. The main seam, at present worked, is 5 ft. 4 in. thick, dip averaging 1 in 12, opened by shaft 13 ft. diameter by 690 ft. The system of working is by bord and pillar, the bords being 17 ft. wide. In 1899 the management began working by long wall in one district of the mine, also commenced working the pillars under the ocean, where there is 1,000 ft. of cover overhead. A feature that excited the interest of the party was the substantial hoisting and pumping plant. The hoisting engines have two horizontal cylinders, each 36 in. diameter by 5 ft. stroke; drum 18 ft. diameter, drawing two tubs of coal in a cage at once, and hoisting 126 tons per hour. The pumping plant comprises one Cornish pump, vertical, 68 in. diameter by 9 ft. stroke, raising about 550 imperial gallons per minute and working 9 hours per day. Pumps are in two lifts, each 20 in. diameter by 336 ft. in height. One forcing set, steam cylinder, horizontal, 30 in. diameter by 4 ft. stroke, pumps about 42 gallons per minute, in one column of pumps, which are 8 in. diameter by 360 ft. in height. The water from the faces of the workings at the dip is pumped to the shaft bottom by two duplex pumps; one Northey 4½ x 2½ x 4 in. forces the water to a distance of 2,960 ft. back from the working faces and to a vertical height of 280 ft.; the other, a Northey, 7½ x 4½ x 10 in., forces the water thence to the pit bottom, a distance of 3,194 ft. and to a vertieal height of 209 ft. 9 in. These two pumps are actuated by compressed air produced on the surface and carried to the pumps in malleable iron pipes. The plant altogether is very complete and efficient. The average output of the colliery for the past three years has been about 270,000 tons per annum. The colliery has returned satisfactory dividends to the shareholders for a great many years.

On returning to Mr. Brown's house the whole party were entertained to luncheon, and the remainder of the afternoon was spent basking in the sunshine and in wandering about the beautiful gardens. Before parting Mr. Theo. D. Rand, Treasurer of the American Institute, expressed in a few graceful sentences the cordial appreciation of the courtesies which Mr. and the Misses Brown had shown them. Three hearty cheers were then given for their delightful hosts, and the party drove back to North Sydney greatly pleased with their delightful outing.

ARRIVAL IN NEWFOUNDLAND.

In the evening the party boarded the finely appointed little steamer *Bruce*, which Mr. Reid, the proprietor of the Newfoundland Railway, had generously placed at their disposal. The rugged and picturesque harbor of Port aux Basque was reached early next morning, and connection was immediately made with the regular train for St. Johns, which was found in waiting at the pier. The run through Newfoundland by daylight was a source of intense enjoyment to everyone, the rich variety and great natural beauty of the route being a subject of general remark. St. Johns was reached at mid-day where the Crosby House was made headquarters.

A MEMORABLE MORNING.

On Sunday morning those who proposed inspecting Bell Island left St. Johns for Killegrew's on a special train which Mr. Reid had again courteously placed at their disposal. The morning was cold and windy and wet, and when the party arrived at Killegrew's the prospect was cheerless in the extreme. The driving gale had raised an ugly looking sea, rendering it impossible for the tug to make the wharf; she lay, therefore, rocking and tossing some distance outside. It was, therefore, necessary to go through the surf in a small boat. Mr. R. E. Chambers, M.E., manager of the mines of the Nova Scotia Steel Company, accompanied by Mr. W. L. Grammer, manager for the Dominion Iron and Steel Company, together with a party of other officers from these companies, had just landed from the tug, and in making the shore had a very close call from being swamped.

We found them on the beach drenched to the skin, and blue with the cold, none of them presenting that cheerful cast of countenance characteristic of these genial good fellows. The outlook was so bad that many were in favour of postponing the trip. However, while this was being discussed a fishing cobble was rapidly made seaworthy by a crew of sturdy fishermen, and in it about half the party made the tug in safety, while the others, disheartened by the inclemency of the weather and the prospect of *mal de mer* or a ducking, took the train home again.

AT THE BELL ISLAND IRON MINES.

Those of us who ventured our precious carcases in that rickety looking old cobble are very far from regretting the memorable experience; neither will we ever forget the great kindness that everyone showed us, nor the exceedingly delightful day we spent visiting these great iron beds on the beautiful shores of Bell Island. After a stormy trip across, and a long, wet, but not very muddy climb over the tram-line, Mr. Chambers and his staff received us at his house and entertained us most hospitably to lunch. After noon the skies cleared, the wind fell, and Old Sol smiled genially upon us as we wandered over the mines. So much interest has been excited in these unique deposits that we may, perhaps, be excused for reproducing here a description of them, by Mr. Chambers, which appeared in the *Review* some time ago.

Mr. Chambers says—

Drills at work on the Red Hematite deposits of Bell Island, Newfoundland.

"In Conception Bay, Newfoundland, about mid-way between its entrance and its head is situated Bell Island.

This island is eight miles long by two wide, and is about 35 miles by water from St. John's. Upon its northern shore are stratified beds of hematite, which, on account of accessibility, quality, and ease of mining, are likely to come into prominence during the next few years.

The measures containing these beds consist of shales and hard sandstones, and are said by the Government Geologists of Newfoundland to be of Silurian age. The underlying measures are seen on Little Bell Island, Kelley's Island, and upon the shore of the bay at Topsail, where the lowest beds consist of limestones reposing at a high angle upon the Huronian and Laurentian formations of Avalon Peninsula.

The beds containing the iron ore are even and unbroken, and lie at an easy dip to the northward.

Beneath is a great thickness of white sandstone, while in the immediate neighbourhood of the ore are several thick shaley bands of dark color. There are in all five beds of ore exposed in the cliffs upon the northern side of Bell Island. Three of these extend over so small an area and are so thin that they are not of commercial value, and for this reason will not be here again referred to. The two lower beds are of larger size, and extend over wider areas.

The outcrop of this bed is seen in the cliffs on the north side of the island, its western extremity being at Ochre Cove and its eastern near Gull Island Head.

It is first met upon the tramway at a distance of 8,600 feet from the pier. From this point the distance is one one mile to the eastern end of the outcrop, and two and one-half miles to the western end. At the open cut near the tramway the section shows ten feet of clean ore. At Gull island head the bed is eight feet thick, and at Ochre Cove seven feet, the average of the whole bed being probably eight feet.

At the western end the dip is N. 19° E. 70°. This increases a few degrees going east, and the dip changes towards the north. Along this outcrop of 3½ miles not any dislocation of the strata has been found, and the ore is exposed over most of its extent. This gives unusual facilities for open-cut working. There is little doubt but that 200 feet of this outcrop can be mined open-cut over the greater part of this distance, giving 2,000,000 to 3,000,000 tons of ore. When this is worked out many times that amount can be mined underground with natural drainage.

From about 100 analyses made during the past year the composition of this ore is found to be:—

	Per cent.		Per cent.
Metallic iron	54.000	to	59.000
Silica	5.000	"	12.000
Alumina	2.000	"	4.000
Phosphorous	.500	"	.700
Sulphur	Trace	"	.012
Carbonate of lime	3.000	"	5.000
Oxide of manganese	Trace	"	.400

THE UPPER BED.

At Station 101 on the tramway the outcrop of another bed of ore appears, overlying the first in stratification and six feet in thickness, the ore is fully equal to the lower bed, the average of eleven analyses from widely separate points giving 57 per cent. in metallic iron. While not extending over so large an area as the lower bed its boundaries are equally well defined, leaving no doubt as to the quantity of ore it contains. The exposure in the cliffs is quite regular at both the east and west ends, and the ore has been test-pitted along the outcrop between.

Over a great part of its extent this bed is denuded of the over-lying strata making it accessible over large areas for open-cut mining.

QUANTITY OF ORE.

The area of the lower bed upon Bell Island is 817½ acres. Counting 10 cubic feet of ore to the ton and considering the bed 8 feet thick which is a fair average.

$$\frac{817.5 \times 43560 \times 8}{10} \qquad 28{,}488{,}240 \text{ tons.}$$

The area of the upper bed is 240 acres and its thickness 6 feet.

$$\frac{240 \times 43560 \times 6}{10} \qquad 6{,}272{,}640 \text{ tons.}$$

This gives a total upon the island of 34,760,880 tons.

The outcrop inland and the exposures in the cliffs give access to the beds from all sides.

SHIPPING FACILITIES.

Conception Bay, to the north-east of Bell Island opens gradually towards its mouth into the Atlantic Ocean, so that with northerly winds the side of the islands on which the ore is situated could not be used for shipping purposes, consequently shipping has to be done on the south side. A small beach near the east end and the situation of the island itself form a perfect shelter from northerly winds, and the mainland being close to hand on the south and east no ocean swell is to be feared from that direction ; consequently the pier is so situated as to be perfectly safe from the wind from almost any quarter of the compass.

The waters of the bay are deep and free from rocks and shoals, the bottom being mud near the pier affords admirable anchorage.

Near the island the admiralty charts show from 8 to 14 fathoms of water on the southern, and from 6 to 20 fathoms on the northern shore. The bay is navigable from 8 to 9 months in the year,

METHOD OF WORKING.

The ore being obtained by open cut work from the outcrop an elaborate mining plant is not necessary. Two systems are employed for excavation. In the first the cars are run by gravity along a track of 2 ft. gauge to the working face, whence after being loaded they run, still by gravity, to the main tramway. This is made possible

Open Cast Workings in the famous Red Hematite deposits of Bell Island, Newfoundland.

by a switch for empties being at the top while the switch for loaded cars is at the foot of a 10 per cent. grade. The track is shifted laterally to keep within loading distance of the receding face.

Another part of the outcrop is worked by a double travelling cable hoist of 300 ft. span. One span is used for stripping the surface, the other for excavating the ore. The towers with boilers and double drum engines are upon trolleys capable of being moved in a direction parallel to the strike as the excavation proceeds. As before the the empties are switched from the main tramway at the top of a grade and dropped by gravity beneath the cable. They are then conveyed by the cable carriage to any part of the working face, whence after loading they are again hoisted and placed in the full track leading to the main tramway. Upon any part of the ore being excavated the whole plant is moved upon the supporting tracks to new ground.

TRAMWAY.

From the mine the ore is conveyed over a double track tramway of 2 ft. gauge and two miles in length to the shipping pier; this is operated by an endless steel cable, $\frac{5}{16}$ in. in diameter, four miles in length. The alignment is perfectly straight. The cable is supported by wooden rollers 25 ft. apart, while at the apices of the grades iron pulleys 2 ft. in diameter are placed. The cable is kept in proper tension by counter-balance weights. The power house contains two upright tubular boilers and a double cylinder stationary engine geared 1 to 20 to two 6 ft. 6 in. bull wheels. One of these operates the cable for the line now working, the other is spare, for any road it may be found necessary to construct.

HAULAGE PLANT.

1st. The original plant was erected in 1895 with the idea of supplying ore to the Ferrona Furnace of the Nova Scotia Steel Company. This called for an output of only 200 tons per day, with a possible increase to 500 tons.

This plant consisted of a hopper pier of 2,000 tons storage capacity, and an endless rope tramway connecting the pier with the mine. The haulage engine was at the mine. The mining being simply quarry work, did not require an elaborate outfit.

2nd. All demands for ore were easily met by this arrangement until the summer of 1898, when the possibility of shipping ore to the European markets called for an increase. The experience of the previous two years had shown the necessity of increased storage capacity at the pier in order to give quicker despatch to steamers. It was estimated that an extension of the system of pier hoppers would cost over $100,000 for an increased capacity of 10,000 tons, whereas the excavation of pockets in the rock ashore would give a capacity of 20,000 tons for an outlay of $40,000. The latter plan was adopted, the contemplated output being 2,000 tons per day. To carry the ore from bins to steamer, a distance of 550 feet, a horizontal conveyor was put in. This was designed and made by the Nova Scotia Steel Company, and contemplated a capacity of 600 tons per hour at a speed of 100 feet per minute. In

operation, however, by increasing the speed, it has easily hauled 1,100 tons per hour, including stops for shifting the ship, so that the actual working capacity has probably reached 1,400 tons per hour.

To supply the additional ore for this output tramways were built along the crop of the lower bed of ore 2,600 feet east and 6,500 feet west. Quarries were opened at the end of each line. These branch lines were operated by endless cables driven by bull wheels at the central station which received their motion from a shaft driven by a bull wheel on the main cable. To minimize the handling of coal, a new haulage engine was placed at the pier. It is a compound condensing engine with cylinders 13 in. and 26 in. diameter by 4 ft. stroke, and receives steam from three vertical tubular boilers.

During the season of 1899, this plant easily met the requirements. There were sixty-nine steamers loaded of an average carrying capacity of 4,500 tons each, the total shipments for the year being 302,000 tons. The record for quickest loading was on Sept. 28th, when the *Claudius* was loaded with 6,000 tons in five hours and fifty minutes, or over 1,000 tons per hour.

3rd. The sale of a part of these ore deposits to the Dominion Iron and Steel Co. took place in the summer of 1899 and comprised the lower of two parallel beds of ore, together with the equipment. This company contemplates a consumption of 800,000 tons of ore per year in its furnaces at Sydney. This, taking into account the length of the working season at Wabana, means an output of 5,000 tons per day. To meet this increase, a tramway has been built direct to the west mine from the pier, and additional haulage machinery installed to operate it.

Several new openings along the tramways running east and west from the old central station have been made. These will deliver their ore over the old system, while all the ore from the West Mine, where the facilities for working are unusually good, will come over the tramway just built. These lines can be operated separately and independently of each other.

To the west of West Mine is an outcrop on the lower bed of one and a half miles along which it is the intention to construct a tramway operated by cable. On completion of this line every part of the outcrop of both beds will be reached.

To meet their sales for 1900 the Nova Scotia Steel Company have constructed a new pier half a mile to the west of the old one and fitted up a tramway connecting with their new mines on the upper seam of ore. The water at the pier has a depth of over 27 ft. at low tide. A conveyer is erected, similar in type to the first one, but with larger buckets, which should give it a somewhat larger capacity. This conveyer will bring ore from pockets in the rock having a capacity of 40,000 tons. To construct these pockets, advantage was taken of a natural gulch on the shore, giving a large capacity without an excessive amount of excavation.

The tramway has branches extending east 3,600 feet and west 4,100 feet along the crop of the upper bed.

Open Cut on Seam about 18 feet thick worked by Dominion Iron and Steel Company at Bell Island, Newfoundland.

Instead of separate cables for the side lines, in this system one rope operates the main line and branches. It is six and three-quarter miles long, of one inch diameter plough steel, Lang's lay. Travelling at a speed of 240 feet a minute with cars spaced eighty feet apart, it should haul 360 tons an hour, or with a very large reduction for stops, should easily handle 2,500 tons per day.

The mining from the upper bed, as from the lower, consists simply of quarry work. There are in it from 1,500,000 to 2,000,000 tons which can be won by open cut.

Underground mining has not yet been commenced in the district. The situation of the beds, however, is unusually favorable for its prosecution. The character of the ore in the two beds is very similar with one or two per cent. of metallic iron in favour of the contents of upper bed."

The Newfoundland party left St. John's on Tuesday, September 4th, by the s.s. Bonavista, which Mr. Whitney had kindly placed at their disposal for the trip to Sydney.

The sail across was delightful, the genial Captain Fraser being assiduous in his attention to the comfort and pleasure of the whole party. Sydney was reached on Thursday in time to make connections with the Intercolonial Levis express. Thus terminated a memorable outing, brimful of interest and enjoyment.

ANNUAL GENERAL MEETING.

MONTREAL.

WEDNESDAY, THURSDAY, FRIDAY, 6TH, 7TH AND 8TH MARCH, 1901.

The annual General Meetings of the members of the Canadian Mining Institute were held as usual in the Club Room, Windsor Hotel, Montreal, on Wednesday, Thursday, and Friday, 6th, 7th, and 8th March. There was a large attendance of members, including quite a number of mining students from McGill University, Montreal, and Queen's University, Kingston.

WEDNESDAY SESSION.

The sessions opened on Wednesday afternoon at three o'clock. Mr. John Hardman, S.B., M.E., Montreal, being called to the chair, in the unavoidable absence of Mr. S. S. Fowler, the President.

The minutes having been held as read:—

NEW MEMBERS.

The Secretary submitted the following names, having received the approval of Council, for election :—

Mr. W. F. ROBERTSON, Mining Engineer,
Provincial Mineralogist for B.C., Victoria, B.C.

Mr. FRANK B. SMITH, Mining Engineer,
Fernie, B.C.

Mr. JOHN NORTHEY, Mechanical Engineer,
Toronto, Ont.

Mr. C. D. MAZE, Civil Engineer,
Montreal, Que.

Capt. BRUCE CARRUTHERS,
Kingston, Ont.

Mr. CHARLES H. MACNUTT, Mining Engineer,
Pulacayo, Bolivia, South America.

Mr. F. N. SPELLER, B. A. Sc.
Bureau of Mines, Toronto, Ont.

Mr. HARRY WILSON, Mining Engineer,
Montreal, Que.

Mr. HARRY W. WELLER, Mechanical Engineer,
Montreal, Que.

Mr. D. E. K. STEWART,
Madoc, Ont.

Mr. FRED M. WELLS,
Republic, Washington.
Mr. H. C. FARNUM, Gen. Mgr. Copper King Mining Co.,
Eldorado, Ont.
Mr. ROBERT R. CARR-HARRIS, Civil Engineer,
Kingston, Ont.
Mr. SMITH CURTIS,
Rossland, B.C.
Mr. JOHN DEAN,
Rat Portage, Ont.
Mr. C. A. CHESTERTON,
Rat Portage, Ont.
Mr. H. C. MICHELL,
London, England.
Mr. J. E. ALDRED,
Montreal, Que.

These, together with about twenty others approved by Council, were duly declared elected members, subject to the provisions of the Constitution and By-laws.

SECRETARY'S REPORT.

Mr. B. T. A. Bell, Secretary, presented his annual report (reproduced elsewhere in this volume.)

On motion of Mr. W. Blakemore, the report was unanimously adopted.

TREASURER'S REPORT.

Mr. J. Stevenson Brown, Treasurer, presented his annual report as follows :—

RECEIPTS.

Balance forward from 1899	$ 484 87
Subscriptions	2,563 50
Sale of Journals	7 00
Dominion Government Grant	1,000 00
Total	$4,055 37
Less.	
Disbursements as per Statement	$3,424 76
Balance on hand	$630 61

Audited and found corret.

Geo. McDougall,
H. W. DeCourtenay, } *Auditors.*

SUMMARY STATEMENT

SHOWING DISTRIBUTION OF DISBURSEMENTS TO THE VARIOUS WORK AND BUSINESS OF THE INSTITUTE.

Publications—		
Transactions	$510 00	
Cuts	82 00	
Line Drawings	33 00	
Stenographing, drawing and copying	28 75	
Postage, wrappers, etc.	55 67	
Express and other charges	69 34	
		$778 76
Library—		
Rent	$400 00	
Insurance	14 25	
Care of Library	70 00	
New books	66 00	
Door sign and picture framing	11 50	
		$561 75
Meetings—		
Reporting annual meeting and demonstrations	$60 00	
Secretary's disbursements	67 50	
Council meetings	33 34	
Smoking concert	82 65	
Sydney excursion shortage	91 58	
		$335 07
Legislation—		
Civil Engineers' Bill	$25 00	
Ontario Mining Act	246 25	
		$271 25
Secretary's Office—		
Annual grant	$600 00	
Book case, etc.	25 83	
Postage, telegrams and printing	48 77	
		$674 60
Treasurer's Office—		
Annual grant	$250 00	
Bank charges on cheques and drafts	30 59	
Postage, telegrams and printing	35 50	
		$316 09
General Expenses—		
Balance paid for last year	$95 27	
Presentation to J. E. Leckie	21 55	
Certificates, circulars, postage and express	80 42	
Subscription to Patriotic Fund	250 00	
Subscriptions remitted, members serving with colors in South Africa	40 00	
		$487 24
		$3,424 76

February 1st, 1901.

DEATH OF DR. DAWSON.

Mr. B. T. A. Bell said that every member of the Institute and every mining man in Canada deplored the untimely death of Dr. Dawson, the honoured head of the Geological Survey, and their late Vice-President. As Dr. Ami would present a memoir of the late Director at a later stage of the proceedings he only desired to intimate that the Council had decided to appropriate the sum of one hundred dollars and open a subscription among the members for the purpose of presenting to the Museum of the Survey a memorial portrait of the late Dr. Dawson, and also one of his predecessor, Dr. Selwyn.

Mr. Wm. Blakemore, seconded by Mr. P. Kirkegaard, moved the following resolution :—"That the Canadian Mining Institute, in annual session assembled, desires to place on record its sense of the deep loss sustained by the Dominion of Canada, and especially by the mining profession of this country, in the lamentable death of Dr. George M. Dawson, late Director of the Geological Survey of Canada. It recognises the immense value of the services which he rendered in the important position which he occupied with such distinguished ability, and not least, the high qualities of mind and personal character which he displayed. The Institute wishes further to express its sympathy with his surviving relatives in their irreparable loss, and herewith forwards a copy of this resolution to them."

The motion was unanimously adopted.

SURVEY STAFF INADEQUATELY PAID.

Mr. B. T. A. Bell :—The matter of an appointment to fill the responsible position vacated by the death of Dr. Dawson seemed appropriate to direct attention again to the absolutely inadequate character of the remuneration given to the officers of the Geological Survey. It was little wonder that every year saw the ranks of this important branch of the public service depleted of some of its most valued officials. Only lately Mr. A. P. Low had been secured at a large salary by a Philadelphia Syndicate. Mr. W. A. Carlyle was managing the Rio Tinto Mines, in Spain, at a salary of $25,000 per annum. Mr. Coste, Mr. J. B. Tyrrell, Dr. Lawson, and Dr. Adams, were other examples of members of the Geological Survey who had greatly bettered themselves by leaving the Survey. While, of course, it was not to be expected that the Government could compete with private corporations in the matter of salaries, everyone would admit that the remuneration provided by the Government for the gentlemen occupying positions on the Survey was altogether too small for technical officers. Some representation might well be made to the Government on behalf of the Survey, not only on account of the inferior salaries paid its officers, but

also regarding the wholly inadequate and dangerous character of the building provided for its valuable museum and offices. It was time more suitable premises were provided for the Survey's invaluable collections. He was in favor of sending a deputation from the Institute to press these matters on the Government. (Applause.)

Dr. W. L. GOODWIN (Kingston) endorsed the remarks of the Secretary. Every member of the Institute agreed that the mining men would have to educate the legislators to the importance of the work done by the Survey for the development of the mineral resources of the country. He believed a committee should be appointed to draw up strong resolutions to be presented to the Government on the subject.

Mr. E. D. INGALL, of the Geological Survey, remarked that there was one point that had not been touched upon. The museum which the Institute and all mining men advocated would be a national museum, and the Geological museum would be a portion thereof. At the present time they had many valuable specimens which might be very instructive to those interested in mining, but they had to keep these specimens in boxes, as there was no room to display them. He thought it highly important to secure a safe display for the exhibits. The men in charge could be replaced if the building tumbled about their heads, but the exhibits could not be duplicated.

Dr. FRANK D. ADAMS, of McGill, considered the subject one of national importance. While the Government could not be expected to pay the salaries that are offered by some of the mining companies, the salaries should be such as would be an inducement to good men to remain with the Survey, which had done and was still doing such excellent work for the development of the country.

Professor CARR-HARRIS advocated the appointment of a delegation to draw up resolutions and present them to the Government.

The Chairman appointed the following delegation :—Prof. Carr-Harris (chairman), Kingston ; Dr. Adams, Montreal ; Charles Fergie, Westville, N.S. ; W. Blakemore, Montreal ; B. T. A. Bell, Ottawa ; A. J. Moxham, Sydney ; H. M. Whitney, Boston ; F. H. Clergue, Sault Ste. Marie ; Bernard MacDonald, Rossland ; S. S. Fowler, Nelson, B.C. ; and J. M. Clark, K. C., Toronto.

SCRUTINEERS APPOINTED.

On motion, Messrs. P. Kirkegaard, Charles Brent, and Wm. Blakemore were appointed scrutineers to examine the ballots for the election of officers.

NEXT PLACE OF MEETING.

It was decided to report to the Council the desirability of holding the summer meeting of the Institute in Eastern Ontario, making Belleville headquarters.

CIVIL ENGINEERS' BILL.

PROFESSOR CARR-HARRIS (Kingston) then brought up a matter which he believed was of great interest to every man present and to all mining men. The Canadian Society of Civil Engineers had made an effort to establish themselves as a close corporation. These efforts had been unsuccessful several times in Ontario and in the Dominion Parliament. They had also failed once or twice in Quebec but finally had succeeded in getting their act of incorporation through the Legislature of this Province. He himself had joined the Society years ago on the understanding that it was not to be a close corporation but when they tried to obtain legislation to that effect he had left them. He represented that some of the claims laid before the legislators were unfounded and produced letters to show that the Institute of Civil Engineers of England and the Association of Civil Engineers of the United States were not protected by law as close corporations. He invited engineers to join the Dominion Institute of Federated Engineers, which included such men as Sir Sanford Fleming, and welcomed members whether they had gone through the course prescribed by the rival association or not. Professor Carr-Harris concluded by cautioning members of the Institute against entertaining any half way measures or compromises regarding the Bill.

The Session adjourned at 5:30 p. m.

EVENING SESSION.

The Members reassembled in the Club Room at eight o'clock, Mr. Hardman presiding.

The following papers were presented:—

"Across the Pitch vs. Up the Pitch." By O. E. S. Whiteside, M. E., Anthracite, N. W. T.

"Notes on Gold Milling Practice at the Athabasca Mine, Nelson, B. C." By E. Nelson Fell, A. R. S. M., Nelson B. C.

"Leaching Copper Ores by Sulphurous Acid." By E. P. Jennings, M. E., Salt Lake City, Utah.

"Shipping Coal by the Aerial Wire Rope System at Port Morien." By J. G. S. Hudson, M. E., Port Morien, C. B.

"A Simple and Convenient Instrument for Mine Surveys." By Frank Robbins, M. E., Kimberley, B. C.

"Rope Driven vs. Direct Driven Colliery Fans." By Francis T. Peacock, Montreal.

"Pioneer Work on The Crow's Nest Coal Areas." By Wm. Blakemore, M. E , Montreal.

"On the Iron Ore Deposits of Bilbao, North Spain." By Dr. Frank D. Adams, Montreal.

INSTITUTE RECOMMENDS DR. ADAMS AS SUCCESSOR TO DR. GEORGE M. DAWSON.

On the conclusion of Dr. Adams interesting and valuable paper which was beautifully illustrated by lantern projections, the Secretary stated that his attention had been called to an item in the evening paper announcing that the appointment of a successor to the late Dr. Dawson, Director of the Geological Survey had not been made. In this connection he desired to say that at a meeting of the Council held on the previous evening the Council had unanimously agreed to recommend to the Government the appointment of Dr. Frank D. Adams. Dr. Adams was eminently qualified to fill this important and responsible position. (Applause.) He would therefore on behalf of the Council submit their recommendation for the endorsement of the meeting

Mr. James F. Lewis (Sherbrooke) said he had very great pleasure in moving that the recommendation of the Council nominating Dr. Adams be approved.

The motion having been agreed to unanimously the Secretary was instructed to forward the following telegram to the Hon. Clifford Sifton, Minister of the interior:—

> "Canadian Mining Institute at a large and representative meeting tonight unanimously recommends the appointment of Dr. Frank D. Adams, an old member of the Survey staff and Logan professor of geology at McGill, as successor to the late Dr. G. M. Dawson."

INVITATION TO VISIT THE MINING LABORATORY AT McGILL.

Dr. Porter at McGill extended to the visiting members the usual invitation to visit the mining laboratories of McGill University which they would find most interesting.

MEDAL FOR STUDENTS.

The Secretary intimated that the Council had decided to appropriate Friday morning for a Student's Session and that their President elect, Mr. Charles Fergie, had agreed to donate a gold medal for the best Student's paper contributed to the proceedings of that session.

The meeting adjourned at 10:30 p. m.

THURSDAY AFTERNOON.

The members met at three o'clock, Mr. Hardman in the chair. The following papers were presented :—

"Notes on the Magnetic Iron Sands of the North Shore of the St. Lawrence." By Mr. J. Obalski, Inspector of Mines, Quebec.

"On the Occurrence of Nickel in Oregon." By Dr. A. R. Ledoux, New York.

"On the Treatment of Auriferous Mispickel Ores." (Two papers). (*a*) By Mr. P. Kirkegaard, Deloro, Ont. (*b*) By Mr. Sydney B. Wright, Deloro, Ont.

After discussion on these papers Dr. Henry M. Ami presented a comprehensive sketch of the life and work of Dr. George M. Dawson.

The meeting adjourned at 5.45 p.m.

THURSDAY EVENING.

Mr. Hardman took the chair at 8.15 p.m.

AUDITORS APPOINTED.

On motion, Messrs. H. W. DeCourtenay and George Macdougall were reappointed auditors for the ensuing year.

Dr. GOODWIN then presented his paper "On the Analysis of Corundum and Corundum Rock."

NOTICE OF MOTION.

Mr. J. STEVENSON BROWN, Treasurer, gave notice that at the next Annual Meeting of the Institute he would move that all rebates on Provincial Societies' subscriptions be abolished.

MINING PROGRESS IN 1900.

Mr. B. T. A. BELL, Secretary, then presented the balance of his annual report reviewing the progress of mining in the various Provinces during 1900 (reproduced elsewhere.)

Mr. E. D. INGALL, Chief of Division of Mineral Statistics, confirmed the estimates of production given by Mr. Bell, and pointed out that one interesting feature he had omitted was the fact that phosphate is being shipped from Tennessee right to Buckingham, which used to be the centre of our phosphate industty.

MR. W. BLAKEMORE—I should like to say a few words on the extremely interesting and valuable report presented by our Secretary. The only difficulty is to grasp so much material as he has laid before us. Whatever else may have happened, it is evident we are face to face with a very large and satisfactory increase in the mineral production of Canada. An increase of 35 per cent is certainly very large. An interesting feature is that some of these developments are even more significant than the value indicates. For instance, the very large increase in the output of coal is significant, for all our industries, or nearly all, are dependent upon coal, and the large increase indicates the busy state which prevails in our other industries. We are all aware of the gigantic steel plant that is being developed and which was wanted to promote the consumption of our ore in Canada. There is no doubt that within a few years this will call for an increase in the production

of coal that we perhaps do not now even estimate and a consequent large increase in population and prosperity. Recently I have been more interested in the west than in the east. You know the effect there upon the smelting industry of a suitable and cheap coke. There is a larger market over the border than in Canadian territory—a legitimate and natural market for Canadian coke and it must go there, because there is no suitable coke produced over the border. As to the difficulty of transportation, that can be overcome by standardizing the narrow guage railway that runs from Lethbridge, and it would enable British Columbia coke to be laid down at Butte, Condor, and Helena at from $2 to $3 per ton cheaper than American coal. I have no doubt that that enterprise in the West will be the source from which all supplies of coke will be drawn for the West for use in both Canadian and United States territory, for smelting purposes. There is another question—that of sending coal from the East further into Canada. All the coal consumed in the centre of Canada comes from the States; but there are indications that it may be possible to send Nova Scotia coal as far west as Winnipeg. With a good waterway from Montreal to the Lakes, which I believe you will have before very long, and with the splendid iron ore from the shores of Lake Superior which is necessary to mix with the Nova Scotia ore to produce perfectly satisfactory results in Cape Breton steel-making, there will be a return cargo for boats which can take coal up to the lakes, and this will make it possible to lay coal down in Winnipeg for less than $7 a ton. I will leave other gentlemen to speak of the lead and silver; but as to the coal, iron, and steel industries, I can see that some of the anticipations in which I ventured to indulge when I came to this country, eight years ago, are being realized. As mining men we wish every success to the great enterprises which are being established in our midst, and which have every reasonable probability of success.

Mr. CHARLES FERGIE moved a vote of thanks to Mr. Bell for his excellent paper.

Dr. GOODWIN—I listened with much pleasure to the secretary's most exhaustive report. There is one part of it I should like to remark on, as being more particularly interested in the mineral development of Ontario, and that is the production of mica. I didn't gather that Mr. Bell gave any figures of the output of this mineral.

Mr. BELL—Yes ; I quoted Mr. Gibson's figures of the production in Ontario. The bulk of the mica produced in Canada comes from Ottawa County, in Quebec, but it is difficult to approximate the value of the output. The figures published by the Government are not to be relied upon, being very much under estimated.

Dr. GOODWIN—I understood Mr. Bell to say that the mica producers had formed an organization of some sort ?

Mr. BELL—Yes, they have formed the Canadian Mica Miners' Association, an organization of which I happen to be the Secretary. We are collecting and have a mass of useful data concerning the consumption of mica which for commercial reasons we desire to keep to ourselves. There is some talk of the producers forming a trust or combine with a view to regulating prices, and extending the market for Canadian mica, but I am doubtful whether this will ever be accomplished.

Mr. A. B. CLABON (Rossland) gave some interesting particulars of the progress of mining in British Columbia, the outlook for which, he said, was never more promising.

The vote of thanks to Mr. Bell having been carried unanimously the meeting adjourned at eleven o'clock.

FRIDAY MORNING.

Friday morning was devoted to a student's session, when valuable papers were contributed by Dr. J. Bonsall Porter and a number of the mining students at McGill.

FRIDAY AFTERNOON.

Mr. P. KIRKEGAARD, on behalf of the scrutineers, reported that the following had been unanimously elected, the officers and Council for the ensuing year being :—

OFFICERS AND COUNCIL, 1901.

PRESIDENT.

Mr. Charles Fergie, Mining Engineer, Westville, N.S.

VICE-PRESIDENTS.

Mr. R. R. Hedley, Metallurgist, Nelson, B.C.
Mr. Graham Fraser, Ironmaster, New Glasgow, N.S.
Dr. Frank D. Adams, Geologist, Montreal.
Mr. Jas. McArthur, Metallurgist, Sudbury, Ont.

SECRETARY.

Mr. B. T. A. Bell, Editor *Canadian Mining Review*, Ottawa.

TREASURER.

Mr. J. Stevenson Brown, Montreal.

COUNCIL.

For British Columbia—

Mr. J. B. Hobson, M.E., Quesnelle, B.C.
Mr. W. F. Little, Colliery Manager, Anthracite, N.W.T.
Mr. E. B. Kirby, M.E., Rossland.
Mr. Bernard MacDonald, M.E., Rossland.

For Ontario—

Prof. Courtenay DeKalb, M.E., Kingston.
Mr. P. Kirkegaard, Mine Manager, Deloro, Ont.
Major R. G. Leckie, Sudbury, Ont.
Mr. R. G. McConnell, Ottawa.

For Quebec—

Mr. George R. Smith, M.L.A., Mine Manager, Thetford Mines, Que.
Mr. James T. McCall, Iron Merchant, Montreal, Que.
Mr. Jas. F. Lewis, Sherbrooke, Que.
Mr. J. Burley Smith, M.E., Montreal.

For Nova Scotia—

Mr. R. E. Chambers, M.E., Bell Island, Newfoundland.
Mr. D. W. Robb, Mechanical Engineer, Amherst, N.S.
Mr. Henry S. Poole, M.A., A.R.S.M., M.E., Halifax.
Mr. G. F. McNaughton, Mine Manager, Forest Hill, N.S.

Mr. HARDMAN, vacating the chair, called upon Mr. Fergie, the President elect, to preside over the meeting, and in introducing him to the meeting referred to his distinguished career in Canada as a mining engineer.

Mr FERGIE, who was received with much applause, then took the chair. He thanked them for the great honour they had done him in electing him as their President, and he promised that during his term of office the work of the Institute and its interests would receive his earnest attention. He called for the co-operation of all the members, particularly in the matter of contributions to their Transactions. He invited members to present their experiences in mining practice. What was wanted was an interchange of ideas and experiences in practical mining work presented in a form most likely to bring about discussion.

Mr. J. M. CLARK, K.C., LL.B., then presented a valuable paper on "Company Law."

Mr. J. LOWLES (of London, Eng.) on being called upon said—It is quite a surprise to me to be called upon, for I cannot claim to be a mining engineer, although very nearly one. I was interested in hearing Mr. Clark make his remarks about the English Company Law, as I was in the House of Commons during the whole time the Bill was before it, and I heard the debates thereon. In one respect I think English company law has been far ahead of company law on this side, because no such thing as issuing treasury stock below par has been allowed. An agreement setting out the whole terms of the contract has to be fyled, and it is open for anyone to examine, so that the whole history of the thing can be seen. There has been this trouble on our side, that company shares have been used too much as gambling counters on the stock exchange. One has to take risks, but there is too much dependence on the front page of the prospectus. People don't examine the enterprise so much as they look at the front page of the

prospectus. I think that Canadians would do well to assimilate their company laws on the English model. The whole intention of the Act was to make company promotion a more honest occupation. I hope that the effect of amendments on our side will result in more attention being given to the purity of company law on this side, and of the assimilating of your company laws more closely with ours. I do hope it will be possible to open up some reciprocal connections on our side with men who will be willing to introduce Canadian stock, without necessarily putting it under English administration, which is more costly than Colonial in these matters. May I venture to make a suggestion that various mining organizations, I mean organizations of mining men, will be doing a service to English investors by having a sort of bureau of engineers whom they can recommend, not only for the higher positions, but also the junior positions in the mine. It would be a real boon if this Institute were to make that provision. I would like to pay my tribute to Mr. Clark for having brought this subject forward, and probably the effect of it will be that you will study English law a little bit more, and perhaps make some amendments in the direction I have indicated. I sincerely hope that the effect of a wider knowledge and greater interest on our side, and the enormous strides on this side, will be that you will do all in your power to justify the confidence many feel in your resources, and the conviction that we can trust our money to capable men, who will see that our interests are taken care of, although so far removed from home—(applause).

Mr. Leslie Hill (Vancouver)—I was much interested in hearing the paper and getting some information about the English Company Act. I feel very strongly about the disadvantage of the issuing of shares so very much below par, and I think it is a very unfortunate way, and has led to a great deal of trouble. It would be much better if we could assimilate our law more to the English law, so that it would be more uniform. I think it would give confidence in England.

Mr. Clark—Perhaps I should have pointed out that when I was talking of issuing stock at a discount I was speaking of provincial Acts. The Dominion Act is practically the same as the English law was before the passing of the recent Act to which I have alluded. Under the Dominion Act, a company having a Dominion charter cannot issue shares at a discount, and they must be paid in cash, unless an agreement is fyled with the Secretary of State. The only difference between the Dominion act and the old English law was that the agreement had to be fyled with the Secretary of State in Canada, and in England with the Registrar of Joint-Stock Companies. Very few of our companies have been incorporated under Dominion law.

Mr. LOWLES—What percentage, do you know?

Mr. CLARK—About one in a hundred.

Mr. RUFUS H. POPE, M.P., at the request of the secretary, made a few remarks. He expressed pleasure that the English act had been improved, as when he was over there on a visit he thought criticism might be offered on their methods of doing business. We required capital very badly in Canada in our mining business, and many of us had felt, when we went to England, that there was too much money wanted to remain in London before it found the mine. A large portion of the money of Canada was locked up in the banks of Canada. Bank directors had to be exceedingly cautious, and the older they got, the more cautious they grew, until they became of no use either to this country or anywhere else. It had come to this stage today, that if you went to a bank with the best possible paper, no matter whose good names might be on it, the bank would ask if the money was to find its way into mining in any shape or form. If the answer was in the affirmative, the money was refused. Therefore it would readily be seen why we were particularly short of capital. He considered this a reflection upon the whole mining industry of this country. Bank directors were quite right in shutting down on matters which had no basis; but when a property had become a sure fact, and required a little more money to complete it, he did not see why banks should not consider good names in the same way as they would for a pulp mill or any other factory. Mining was just as essential as any factory for the advancement of the country. It was about time that the Dominion Parliament told these gentlemen that they must be patriotic as well as business-like in the use of the public money which Parliament gave them a charter to lock up—(Applause).

Prof. W. G. MILLAR presented his paper on "The Iron Ore Fields of Ontario," which, after discussion, was followed by one from Dr. H. M. AMI on "The Sedimentary Formations of the Province of Ontario, and Boring Operations carried on in them."

After discussion, the members adjourned at six o'clock.

ANNUAL DINNER.

In the evening about seventy members and their friends sat down to dinner in the Windsor Hotel. After an excellent collation, a thoroughly enjoyable evening was spent in song and sentiment, speeches being limited to three minutes. A splendid programme of vocal and instrumental music was carried out under the auspices of the Zingari Glee and Banjo Club, who most generously volunteered their services for the occasion.

PAPERS.

Notes on Gold Milling Practice at the Athabasca Mine, Nelson, B.C.

By E. Nelson Fell, A.R.S.M., Nelson, B.C.

The following notes may prove of interest, not on account of any especial features introduced into our process, but on account of the peculiar character of the ore treated. A casual inspection of the ore on the floor of the breaker room would create the impression that the ore is not suitable for milling at all. The general features are a hard blueish quartz, containing a large proportion of sulphides of zinc, lead and iron, showing free gold only when the ore is of fair grade, say from $30.00 per ton upwards in gold values; and then usually closely associated with the lead and zinc sulphides. At times the entire ore body consists of solid sulphides, usually under these circumstances of either iron or zinc. We are not in the habit of making regular analyses of the ore, but in December we took a sample from the ore pulps of the mill runs of December 2nd to December 15th inclusive. The ore at this period was what we call medium to low grade, and its contents were as follows:—

Gold	1.35 ounces to the ton.
Silver	45 " "
Zinc	2.20 per cent.
Lead	1.60 "
Iron	10.70 "
Sulphur	6.00 "
Silica	68.80 "
Lime (Ca O)	1.90 "
Alumina ($Al_2 O_3$	6.00 "

In general the ore may be described as high grade, as the average gold contents recovered in the mill, during last year, was over one and one-half ounces per ton and during the month of June reached very nearly three ounces per ton. A peculiar feature of the ore, and one which no doubt materially assists recovery in the mill is the free gold which is found imbedded in the zinc and lead sulphides, in samples

where no sign of quartz is visible. I have before me a remarkable sample of fine grained galena, one inch high, ¾ inch broad and ½ inch thick, which is pierced by a wedge of gold, shaped like an Indian arrow head, ¾ inch long, $\frac{3}{16}$ inch broad at the base and tapering to a point at the other end. The mill contains ten stamps, working in two batteries of five stamps each. The frame is of the front knee type. The battery posts are 12 x 25½ inches, the knee frames are 12 x 17 inches and the girts are 12 x 13½ inches. The whole is bolted together in the usual way and these dimensions seem to secure perfect solidity. The cam shaft is of steel, 5¾ inches in diameter, fitted for Blanton cams. Ours are arranged in the order of drop 1, 3, 5, 2, 4, and while this plan does not seem suitable to our case, we are unable to experiment with any other style without a new cam shaft. I think it would be an improvement if, in sending out these shafts, the manufacturers should drill them for the wedges, so that the order of drop could be changed. We find that the pulp banks up around No. 1 stamp and this both impedes the action of this stamp and interferes with the amalgamation in this end of the mortar. With a view to overcoming this difficulty our practice is to give the end stamp about one-half inch more drop than the middle stamps. The cam shaft works in open boxes, a system which we have proved to be thoroughly satisfactory. The guides are individual guides of maple with the grain of the wood up and down. Each guide block is held together by two ⅜ inch bolts running across the grain of the wood, with head and nut countersunk. Each pair of guides is held in place by two ⅞ inch bolts running through the guide rail. A hard wood wedge is driven home between each end pair of guides and the battery posts, and secured by a bolt. These guides give excellent service, if care is taken to have the guide blocks thoroughly seasoned before fitting; the cost of renewal is very slight, and they have the inherent advantage of all sectional guides.

The cams and tappets are of steel; the latter are fitted with three keys; after 24 months wear we have not yet had occasion to turn one tappet, and the cams show no sign of wear; they work smoothly and consume practically no grease.

The stems are of steel and we have not yet, after twenty-six months

use, had occasion to even turn one of these, which is eloquent testimony in favor of our style of guides. The bosses or heads are of cast iron, and the shoes and dies are of forged steel. We have tried various much recommended special compounds and have found none so satisfactory as the forged steel. They last longer, wear more evenly and can be safely used, if desired, down to a feather edge.

The stamp when new weighs 980 lbs. and the speed varies from 80 to 115 blows per minute according to the requirements of the time, with a drop of from five to eight inches.

Under these conditions the mill has made a good running record. We stop on the first day of each month to clean up the amalgam in the mortars, lace belts and so forth, which stoppages aggregated last year, eight days and seventeen hours, besides these delays we lost four days and twenty hours. Our motive power is entirely water; working under a head of 398 feet. We employ two impact wheels, one being a motor two feet in diameter, which operates the stamps, the rock breaker, the electric light plant and the cyanide plant, and the other being a twelve inch motor which operates the vanners only, and of which the speed is never changed.

The mortars were supplied by Messrs. Fraser & Chalmers and are described in their list as No. 50. The width of the mortar at the point of discharge is 14½ inches. The height from the top of the die (when new) to the bottom of the screen discharge is 6½ inches and the die is 6½ inches deep; when the die is worn out, the height of the discharge is as much as 11 or 11½ inches.

The screens are of the diagonal slot pattern, and our practice is to employ a 50-mesh screen when the dies are new, a 40-mesh screen after 30 days wear and a 30-mesh screen when the dies are wearing low. It is evident that a mortar arranged on these lines is not designed to attain high records of crushing, and the greatest tonnage which we have put through, was during the month of January, 1899, when we crushed 713 tons in 30 days, 7 hours, or 2⅓ tons per stamp per day. The pulp after passing over the plates is sized in a cone sizer and passes in grades of size to four Frue vanners; the first or coarsest grade passing over a four foot corrugated belt and the other three grades passing over six foot plain belts. The tailings from the vanners have, up to the

present time, received no further treatment, but from this time forward will be treated in the cyanide plant.

Copper Plates.—These are arranged as follows :—

1 Back plate inside the mortar.....	10½ in. x 51½ in.
1 Chock block plate inside the mortar.	3¾ in. x 50 in.
1 Lip plate outside the mortar.....	8 in. x 54 in.
1 Apron plate outside do	56 in. x 120 in.

All are electroplated with 1½ ounces silver to the foot. The apron plate has a fall of 1½ inches to the foot and just sufficient water is kept flowing over it to keep the pulp from banking on the plate.

The practice is to dress the apron and the lip plates five times in each twenty-four hours, using as a cleansing solution a warm solution of dilute cyanide and sulphuric acid, the plates are brushed up with a hair scrubbing brush and smoothed off with whisk brooms, brushed across the plates. Fresh quick-silver is applied before the brushing process in quantity as may be necessary. In this way the plates are preserved beautifully soft and clean. The amalgam is removed every two days from the apron plates, a small piece of rubber being used as a scraper for this purpose. Every sixth day the screens are removed, the lip plates are cleaned of amalgam, and all of the trash and chips are cleaned out of the mortars ; but the chock block plate, and the back plate inside the mortar, are only removed and cleaned at the general clean up on the first day of each month.

The amalgam is cleaned with fresh quick-silver and squeezed as dry as possible. In this condition the amalgam from the plates outside the mortars contains about 20 per cent. bullion and the amalgam from the plates inside the mortars from 30 to 45 per cent. bullion.

Assays.—At least four assays are made daily :—

1. Of the ore at the feeders.
2. Of the pulp as it leaves the last plate.
3. Of the tailings.
4. Of the concentrates.

The sample taken at the feeders cannot be considered a satisfactory sample, but averaged over a period of several days, the results are fairly good. For the year 1900 :

The average of the feeder samples was $44.38
do do tailings do $8.71
The theoretical recovery was $35.67
The actual do do $33.66

Recovery.—The theory under which we have been working is that the gold should be given as early and as ample an opportunity as possible to amalgamate, and for this reason we have held to the use of as large plates inside the mortars as possible. For this reason, and in order to preserve the back plate intact, we do not alter the height of the chock block which carries the front inside plate, and in this way the level of discharge is always the same. In this way, there is very little tendency to scour the plates, excepting (to a limited extent) around stamp No. 1 where the pulp is banked up by the action of the stamps; and the change of screens, as aforesaid, offsets the increasing height of discharge which is produced by the wear of the dies. After the run of the month of June, we cleaned off the plates inside the mortars, 3,183 ounces of amalgam, which produced about 925 ounces of bullion or 64 per cent. of all the bullion recovered. During this month our percentage of recovery was 81 per cent. of the value of the ore. My opinion is, that our loss consists, almost entirely, in the sulphides; and that our loss in amalgamable gold is slight. From June until the end of the year, our percentage of recovery steadily fell to 77.6 per cent. in November, corresponding with the proportion of bullion and concentrates recovered.

Month.	Total amount recovered.	Percentage by value of Concentrates to Bullion.
June	81.0 p.c.	21.5 p.c.
July	80.7	24.0
August	79.6	29.2
September	79.4	27.8
October	78.4	29.7
November	77-6	38.7

In order to endeavor to ascertain what proportion of sulphides were being lost, we sampled and analysed our ore pulps during December, as afore described. During this period 230 tons of ore were milled

producing 26.7 tons concentrates which when sampled assayed as follows:—

Gold	2.67 ounces per ton.
Silver	6.00 " "
Zinc	5 5 per cent.
Lead	4.8 "
Iron	34.3 "
Insoluble	17.6 "

If all the above figures are correct and 900 lbs. of ore should produce 100 lbs. concentrates, then

900 lbs. of ore should yield 900 x 2.2 p.c.=19.8 zinc (lbs.)
900 " " " 900 x 1.6 p.c.=14.4 lead "
900 " " " 900 x 10.7 p.c.=96.3 iron "

Actual results are

In zinc we recover 5.5 lbs. or loss of 74 p.c.
In lead " 4.8 " " 67 p.c.
In iron " 34.3 " " 65 p.c.

The absolute accuracy of these figures is open to question, but I am satisfied that the general tenor of them agrees with our results in practice and they point to a serious need of additional concentration facilities. Our experiments, however, with the cyanide process for the retreatment of our tailings, seemed to offer such excellent chances of success, that we decided to instal a plant of this description and did not further consider the improvement of our concentration plant.

Fineness of Bullion varied during last year from 682.5 to 747.5 with an average for the year of 725.3. The fineness seemed to vary as the quantity increased, the bigger the brick, the higher the grade. It also seems to vary inversely with the proportion of concentrates recovered.

The number of tons crushed during the year was 5,054, which produced 520 tons concentrates or 10.2 per cent. by weight of the ore. The actual recovery in bullion was $25.62 and in concentrates $8.03 per ton; of the values recovered the bullion supplied 76 p.c. and the concentrates 24 p.c. The value of the tailings was $8.71 per ton and

the percentage of recovery was 79.4. The tailings have been impounded in a dam pending the completion of the cyanide plant.

Stain on the Plates.—An irridescent brass coloured stain constantly forms on the apron plates; I use the word stain because it is so thin, and in such a fine state of subdivision that when gathered up in water, its appearance is that of a dark coloured solution. Fresh quicksilver when applied to the plate covered with this stain instantly adheres, as readily as though the plate were bright, and it does not seem to interfere with amalgamation in any way. It is instantly removed with the first stroke of the brush, and when the brushing process is ended I have seen the stain reappear within fifteen seconds after the clean water has been turned on, before the attendant has time to release the first stamp. We have only made very slight investigation into the nature of this stain. Without more than suggesting that it has any connection with the above, I may here draw attention to the fact that while the iron sulphides are apparently entirely composed of common iron pyrites, $Fe\ S_2$ =sulphur 53.3 and iron 46.7 per cent.; yet in the analyses of our ores and concentrates, we seldom find more than from ½ to ¾ enough sulphur to satisfy the iron in the formula $Fe\ S_2$, not to speak of the sulphur necessary to satisfy the zinc and the lead.

A curious feature of amalgamation was noted when the mill first started. Amalgam was formed on the front plates in remarkable quantities which when retorted produced an insignificant amount of retorted sponge.

During the first ten days of November, 1898, 1,755 ounces of amalgam (squeezed dry) produced 161.8 ounces of bullion or 9.1 per cent. This had been even more remarkable during October and the same feature continued during the following three months, after which it became normal.

Melting.—For melting the sponge we use a Braun gasoline furnace with one large burner. The size of the furnace is 10 inches in diameter and 12 inches high, measured inside.

We make bricks weighing from 400 to 500 ounces each. We use a flux as follows

Borax glass	100 grammes.
Bicarbonate soda.	50 "
Glass.	600 "

and stir to excess with an iron rod. After skimming the slag, the brick is poured and is found in the mould with a heavy layer of matte on top. This is removed and the brick remelted under the same conditions. This process insures clean bricks in our case. The matte and slag are saved and, after the product of six months has accumulated, it is retreated in the pot with with nitre and litharge, and the resultant lead is cupelled. The residues are again treated in a similar manner, which second process removes all the value except traces of silver.

Notes on the Magnetic Iron Sand of the North Shore of the St. Lawrence.

By J. Obalski, M.E., Quebec.

Those deposits have always been known, and forty years ago they called largely the attention of business men as being a source of iron ore of the best quallty and of the highest grade.

In 1867, a company called the "Moisic Iron Co." was organized in Montreal; the president was Mr. W. M. Molson, and amongst the directors there were the Hon. L. Letellier, Hon. R. Laflamme, and L. Labreche Viger, M.P. This company bought large tracks of land in the vicinity of Moisic, built on the spot eight bloomary furnaces, using the magnetic sand as ore, and charcoal as fuel. The product of these furnaces was sent to the United States, or used in Montreal at a roiling mill controlled by the company.

Nevertheless, the chief market was in the States, where the product of the furnaces was shipped, submitted to the duty of pig iron, say, 7 per cent. per ton.

In March, 1875, under the protest of the American iron workers, it was declared subject to the duty on bar iron, say 1½ cents per lb,, or 34.80 per cent. per ton, which compelled the company to shut down the work, and to go into liquidation, owing to the absence at that time of a sufficient Canadian market.

In August, 1868, when Dr. Sterry Hunt visited Moisic, out of the eight furnaces built, there were four in operation, giving a total of three tons of iron for 24 hours with 12 men, using 1400 bushels of charcoal, say 466 bushels per ton of iron.

The concentration of the ore was then made by Dr. H. Larue's process, consisting in magnets under which an endless table passes with the sand on it. The magnetic portion was attracted, but there was a fine clothing under the magnet, and by moving it down, the iron sand was put loose and dropped in an adapted receiver. It is said that one ton of pure ore was obtained, out of 2 or 3 of sand per day for each machine.

Several process have since then been suggested for agglomerating the magnetic sand, and in the elaborated report of Dr. T. Sterry Hunt, published in 1866-1869, vol. of the Geological Survey, and in which I have largely taken information for this paper, I remark the name of Mr. R. G. Leckie as the patentee of a process for using that sand properly reduced in connection with the manufacturing of steel by the Martin-Semmens process.

Mr. Labrecque Viger was also the inventor of a process to manufacture directly steel from that ore.

But since the abandonment of this industry, no other attempt has been made, and that immense quantity of iron ore is still there, waiting for the skill and energy of some enterprising concern to be utilized.

A company, called "the Natashquan Magnetic Iron Co." shipped from that place some quantity to England, for trial. I heard that the ore was successfully smelted then, but no practical result was obtained, probably on account of the difficulty of shipment.

Now, after that little historical sketch, I come to the study of the deposits themselves.

I copy again the following analysis from the report of Dr. Sterry Hunt (Geological Survey 1866-1869).

The black sand contains grains of quartz, garnets, and other hard minerals, besides of magnetite and titanic iron. I never found a trace of gold, although itis claimed that there is some.

	MOISIC.			BETSIAMITS.		MINGAN.	
	1	2	3	4	5	6	7
Protoxide of Iron.....	70.10		56.38		24.66		46.31
Peroxide of Iron.....	"	92.68		92.44		86.92	
		"	"	"	22.24	"	"
Titanic Acid.....	16.00	4 15	28.95	3.40	26.95	6.50	31.60
Oxide of Manganese..	"	0.40	1.10	undeterm.	1.10	0.52	1.35
Lime.....	"	0.90	0.95	traces	1.12	0.75	1.06
Magnesia.....	"	"	"	"	0.72	0.70	0.50
Insoluble.....	5.92	1.95	8.75	3.85	23.80	4.20	15.50
	92.02	100.08	96.13	99.67	100.59	99.59	96.32
Metallic Iron.....	55.23	66.73	43.85	66.56	34.94	65.58	36.00

Analysis No. 1 was that of the raw sand, 2, 4 and 6, of the magnetic portions, and 3, 5 and 7, of the non-magnetic.

It will be remarked that all the iron is indicated in the state of protoxide in the analysis of the raw ore or of the non-magnetic portion, on account of the difficulty of determining the degree of oxydation of the iron in the titanic mineral, which explains why the totals of the analysis are so much below 100.

The two next analysis were made in Belgium, in the laboratories of metallurgical companies :

Protoxide of Iron	28.04
Peroxide of Iron	71.07
Sulphur and Phosphorus	00.00
Equivalent to metallic iron	70.56

Oxide (magnetic)	91.719
Insoluble silicates	1.082
Alumina	3.340
Lime	2.750
Magnesia	0.389
Sulphur	0.099
Phosphorus	traces
	99.379
Metallic Iron	71.337
Phosphorus	traces
Sulphur	0.039

Analysis of Moisic pure sand, by Professor Stillman, of Stevens Institute, Hoboken, N.J. :

Oxide of Iron	96.67
Phosphorus	0.03
Sulphur	traces
Manganese	0.33
Titanium	0.00
Insoluble matter (silicate of Alumina)	2.88
Undetermined	0.09
	100.00

Equivalent to 70.01 of metallic Iron.

ANALYSIS OF NATASHQUAN ORE.

	1	2
Metallic Iron	70.31	71.94
Silica	.68	.22
Sulphur	.014	.026
Phosphorus	.043	.030
Titanium	.370	.420
	3	4
Metallic Iron	69.780	69.68
Phosphorus	.015	.005
Sulphur	.011	.021
Titanium	.860	.000
Silica	.321	

Those analysis made recently have been communicated by Mr. R. T. Hopper from concentrated ore obtained with a special machine of which he has the control. They show that he practically got rid of the titanium. Mr. Hopper has made important prospects and experiments on the black sand, specially on the ore of Natashquan.

By 1865, there were many applications for land on the Coast, and the Quebec Government had a few townships partly surveyed, and many lots sold for mining purposes.

Since that time, there was nothing done, but for a couple of years, some prospects have been made, and we have received many inquiries regarding the black sand. Eighteen months ago, I made a personal visit to the Coast, from Sheldrake to Natashquan, with the result that I was very favorably impressed by the magnitude of those deposits. It must be remarked that the sand does not occur all along the coast, but only in several places, the most important being Natashquan, Moisic and St. Jean.

I have not visited the Moisic deposit, but from several reports I have in hands, I understand that the quantity of black sand is large, and extends for quite a distance east of Moisic river. The nearest harbor is the Seven Islands bay, 16 miles from Moisic.

I give below my impression on the deposit I personally visited.

The beach sand has been produced by the disaggregation of ferruginous rocks of the Laurentian formation including anorthosites, against which the sea has broken during geological periods of indeter-

mined length, and the matter so produced has been subjected to a natural concentration slightly different from that which occurs in an ordinary stream. The waves lift both the heavy and the light elements, but when they recede, they carry away chiefly the light elements, leaving the heavy ones on the beach; this operation repeated a great many times, causes deposits of greater of less thickness according to the strength of the waves. The wind also produces its effect by covering up the heavy deposits with layers of lighter sand. All these facts may be ascertained when a hole is dug in the beach, and the different layers of varying thicknesses and with varying percentages of metal are examined. Nevertheless, these deposits are chiefly observed about the low points, denuded of rocks, and their number is limited. It is very probable that the sea level has been lowered, and that, as the same phenomena occurred formerly, similar deposits may be found in the low-lying spots at a certain distance from the present sea-shore. This fact seems to have been ascertained by explorers and surveyors, and in the reports of the Department of Crown Lands and of Mines for 1899, a few facts are recorded regarding this point.

Dock Bay.—Immediately above the fishing station known as "Dock Bay," between Thunder and Jupitagan rivers, a little black sand is found in the bay, on a length of 500 feet and a width of 30 feet. On a point where the shore has been eaten away by the sea, there is a thickness of 10 inches surmounted by 5 inches of yellow ochre.

St. John River.—This deposit extends from the mouth of that river for a distance of 6 miles to the North East, but the greatest development is in sight at Pointe Noire, 4 miles from the river St. John. The black sand is visible on the surface in beds more or less rich, with a thickness varying from 2 or 3 inches to 10 inches. I measured the beach from low water mark to 100 and 300 feet where there is an intricate growth of small spruce trees making it difficult to see anything; but this soil may also contain ore. The river St. John can be entered only at high water and by small schooners.

From Pointe Noire to Mingan river, the shore is flat and the sand is also mixed with black sand. I did not find a great abundance of it,

but as the action of the sea alters the look of those beaches, according as the black sand is more or less on the surface, it is possible that there may be enough to work at or at least that by prospecting a little inland, it may be found in greater quantities.

The nearest deep water harbor is Mingan, but the river St. John could be used for loading small schooners or barges which could be towed to Mingan (12 miles), for supplying large vessels.

Continuing along the coast, I found but little black sand, the shore being generally rocky. At Esquimaux Point, the beach is sandy, but I did not find it in workable quantities.

Great Natashquan River.—From the mouth of the river towards the East, for a distance estimated at 20 miles, there is in sight between the low water mark and the timbered ground, a stripe of sand formed by the flat beach from 100 to 400 feet wide, and of dunes ranging from 5 to 50 feet in height, and extending backwards 600 feet from low water mark. The black sand is distributed all through that area in alternate layers of varying thickness, going from 1 inch to 2 feet with a practical yield of black sand from 20 to 95 per cent.

I have measured sections of the dunes which for 15 and 20 feet in height would give from 40 to 60 per cent. of black sand as an average. It can be seen also on the East shore of the Natashquan river itself.

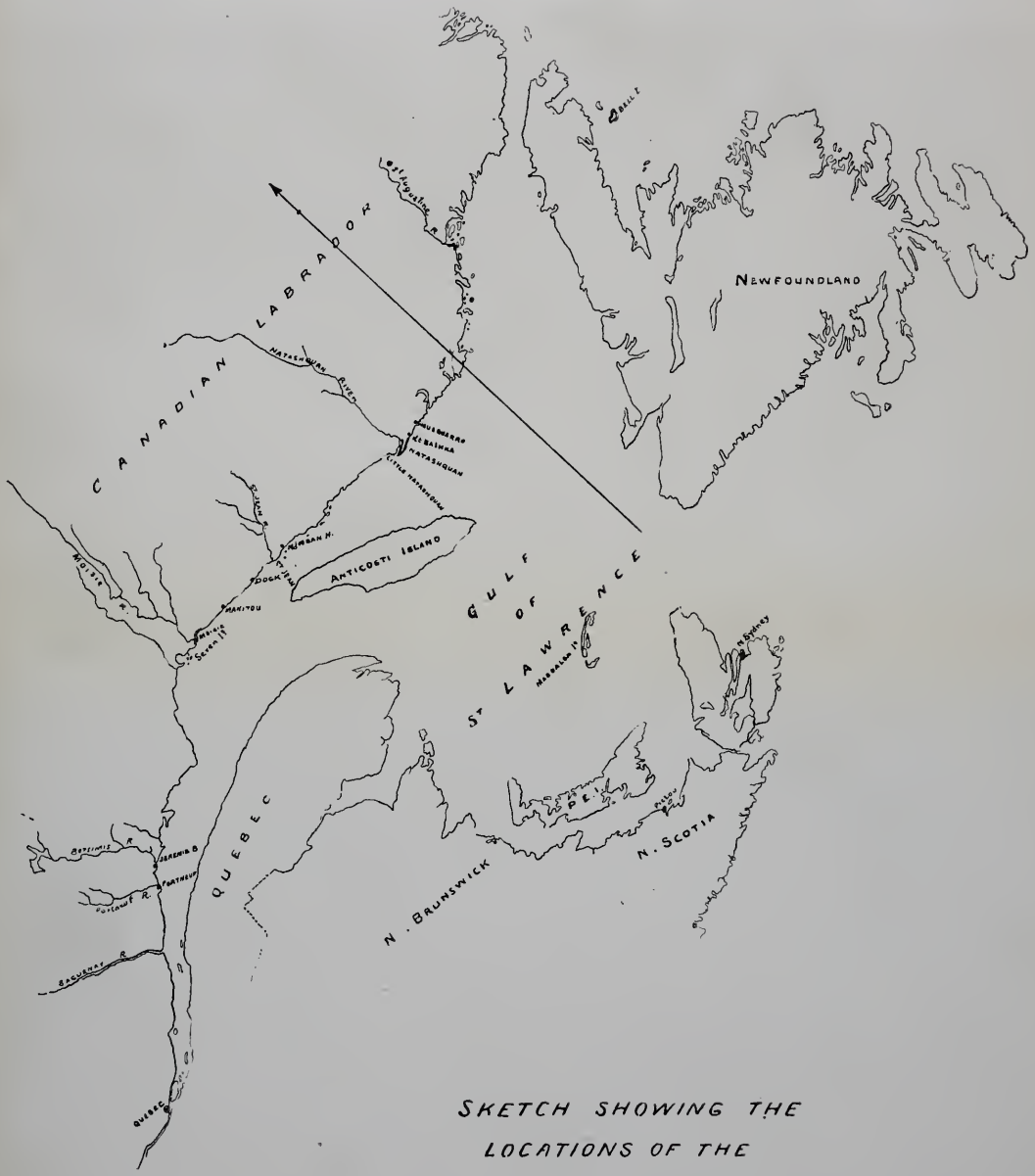
It is said that it continues as far as Kaghaska river and is found in this bay and the Musquarro.

The average proportion of black sand may be considered as 40 per cent., the quantity of pure magnetic iron being 25 per cent., containing from 68 to 70 per cent. of magnetic iron. I will remember that the theorical yield of this ore is 71.78 per cent.

Now, if we take an average depth of 20 feet, a width of 600 feet only, we will have, for each mile, over 1½ million of tons of pure ore of 68 to 70 per cent. of iron, taking 300 lbs. as the weight of a cubic foot of such ore.

The tonnage is considerably larger, as we take only 600 feet of beach to the line of trees.

This beach, as well as the others I have seen, is exposed to the sea, and there is no harbor in the immediate vicinity, the nearest being



SKETCH SHOWING THE LOCATIONS OF THE BLACK SAND DEPOSITS

SCALE : 100 MILES TO AN INCH

that of Little Natashquan, 4 miles to the west of Great Natashquan. This harbor is well protected, and could easily be made accessible to vessels of heavy burthen. It is surrounded by granitic hills and protected towards the sea by islets of the same rock.

On the Great Natashquan, 12 miles from the sea, is the first fall, 30 or 40 feet high, which could supply the motive power for large mills, and it is followed by three other falls separated by intervals of from two to three miles.

According to the above, the beach deposits are generally in sight for several miles on low shores exposed to the opon sea and without harbors or shelter. Large vessels loading ore there would have to anchor at a rather considerable distance from the shore, and special flat-bottomed lighters of somewhat small dimensions would be required to convey the ore in sacks to the large vessels which would hardly be practicable. In the two principal instances where I made an inspection, I consider that it would be completely impracticable to ship the ore direct by sea from the spot whence it would be obtained. It would thus be necessary to seek for the nearest harbors, to have the sand concentrated and purified on the spot and the merchantable product conveyed by tramways to the point of shipment.

It will therefore be seen that the working of these deposits must be done on a large scale, and that it would require considerable capital for the manipulation of large quantities by mechanical process and for purifying and conveying the product to suitable harbors.

The working of the sand should be done by means of steam shovels feeding cylindrical driers, whence the ore would be taken to electro-magnetic separators, several systems whereof have been patented. When separated, the magnetic oxide would be loaded in small cars which, by means of tramways would convey the ore to the wharf where it would at once be loaded on the vessels or be kept in elevators. The motive power could be supplied by the water-power in these regions, and the fuel would consist of fire-wood cut in the neighborhood, or of Nova Scotia coal which could be landed there for $3 a ton at the most.

The season of working would extend from May to October, say six months.

Sufficient ordinary labor could be obtained there cheap, and moreover, the manipulation of the sand should, as far as possible, be effected by mechanical means.

As for the use of that ore, I think that the Iron and Steel Works at Sydney, C.B., could use part of it as a mixture, the distance from the deposit to Sydney harbor being between 3 and 400 miles, and the coaling steamers returning from Quebec could take it as a backward freight to Nova Scotia. The distance from Natashquan to Quebec is about 500 miles, and from Moisic, 300.

The three principal deposits on the North Shore are in the vicinity and to the east of the Moisic, St. John and Great Natashquan rivers, but there are also less important ones at Portneuf, at Jeremie Bay (west of Betsiamis river), at Manitou River, at Dock Bay and in the bays of Kaghaska and Musquarro.

It is also reported that thin layers of black sand on the North West arm of St. Augustin river for a distance of 30 miles.

A Simple and Convenient Instrument for Mine Surveys.

By Frank Robbins, Mining Engineer, North Star Mines, British Columbia.

The excellent paper of Dunbar Scott and the very thorough discussions of the same in the transactions of The American Institute of Mining Engineers for 98-99 make it almost a work of superorogation to write anything upon the subject. However the title of that paper "The Evolution of Mine Surveying Instruments" seems to lead the subject up to "perfection" while the title of this paper indicates—at least I intend it to—a simplicity of construction tending rather to "Involution." It may be well to say however that no one more keenly appreciates accurate under-ground surveys and perfect mine plans than the writer; and none is more inclined to condemn loose and inexact work in this direction.

The experience of all of us no doubt—particularly in mine examinations—tends to show that many mines, especially those which are for sale or are in urgent need of examination, have no plans at all; and in cases where plans exist they are frequently found not posted up to date. It may be taken as an axiom that a perfect report can not be made without a plan, that is, of course, unless it be something that can be condemned at a glance and summed up with a terse "No good." This plan must be something to show where samples are taken; where pay shoots begin and where they end; the reference of one level to another and the hundred and one details which will occur to the engineer.

Let us assume an extreme case: A short option is held upon a mine or prospect, situated in a remote mining district of British Columbia, the mine is reached by a mountain trail from the nearest small settlement 25 miles away, it is 20 miles over a mountain road from the settlement to the nearest small town, from which it is 50 miles of staging to the railway. The clients in Montreal or Toronto have waited

till the last minute before sending the engineer out—probably till the snows have set in—and they are now anxiously waiting for the report.

The mine is reached and it is found that the values are variable, lie in a rather flat vein, and consist of more or less irregular shoots or bodies, these have been opened up by several levels, all as crooked as a ram's horn, there are two or three faults, and the owners have no map of the workings. While the engineer is getting warm an indian messenger comes in with a wire from Montreal or Toronto telling him that it is important that he hurry his report. A plan is essential, there is no time for an accurate survey with careful closing points. What is wanted is something more than a sketch and something less than the perfectly constructed plan of a colliery properly conducted. How often do engineers stumble upon just such cases as this? In my practice I find that they are the rule. Perhaps not in British Columbia where the mine plans are kept up as carefully as the recollection of the catechism.

Some sort of a sketch plan may be prepared with the aid of a pocket compass. I have tried this with an old fashioned mahogony box compass held in my note book, the sides of the book being used as sights—the needle never settled—I have tried it with a prismatic compass; but my points were never certain. I have carried a heavy transit along on such trips, nursing it carefully, in case of emergency; almost invariably in such case to find the mine perfectly provided with plans.

In the light of such experiences I hit upon the "simple and convenient instrument" which gives the title to this paper, and with the aid of the accompanying cuts I will endeavour to describe it.

First I will assume that a compass which may be read to half a degree will come within the bounds of accuracy required. That, when local attraction is manifest, back and fore sights will be taken at every station and the included angle between them read, after the "old country" fashion of "blind dialing." Where attraction does not exist the instrument to be set up at alternate stations, only, and the middle station established by fore and back sights as in the ordinary compass practice. That the bottom plate of the dial have a semi-circle divided thereon, and graduated both ways from the E or W point from O to

90 degrees, with a pendulum indicator suspended from the centre pin traversing this semi-circle by which angles of elevation and depression may be taken when the dial is set in a vertical plane.

Many years ago I came into the possession of a pocket compass, made by Gurley of Troy, N.Y, this consisted of a flat square plate about 5 inches square upon which was set a compass dial with the above pendulum attachment for vertical readings, this compass was provided with two folding sights. It was a good pocket compass. By laying the edge of the square plate upon a wall or upon a ladder I could read slope angles. By levelling it upon a few rocks and lying down upon my stomach in a wet drift I could get a bearing through the two sights with a fair degree of accuracy. By holding it in my hands and averaging the run of the needle through its oscillations I could also usually guess a bearing somewhere within 5 degrees. It struck me that this instrument was susceptible of improvement and that a light tripod to which the compass could be attached would prove a convenience. The tripod was easy enough, the attachment however had to be considered. The ordinary ball and socket joint was the first suggestion; but while this would admit of reading the needle to perfection it would not admit of the taking of readings in the vertical—a *sine qua non* in all mining instruments, I take it. I happened about this time to run across in an old book of mechanical movements the cut of an universal joint—*Goyjot's Joint*, it was called, if my memory serves me—which I thought would do. This consisted of a square block of metal with a bended plate on top and another underneath, these plates being attached to the block by screws running through the latter, one above the centre and one below it and at right angles to each other, thus admitting of the plate "C" passing through a semi-circular arc at right angles to the axis of the upper screw "d". The block "E" has also a range of movement in arc at right angles to that of "C" and around its pivot, the lower screw "d". I made such a joint of wood and sheet brass and saw that that it would answer the purpose. I sent this pattern to John Roach—the old instrument maker of San Francisco—who made for me the joint shown in Fig. 1.

A disc is centered and braced to the bottom of the compass; into

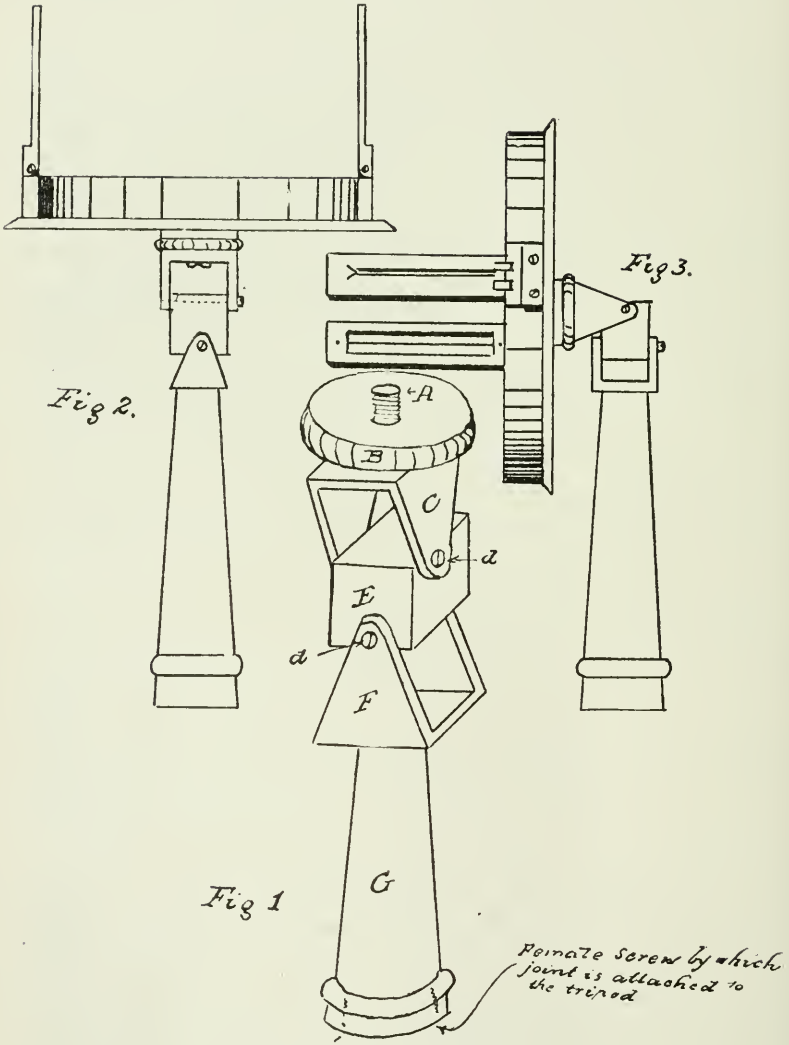


Fig 2.
Fig 3.
A
B
C
d
E
d
F
G
Fig 1
Female screw by which joint is attached to the tripod

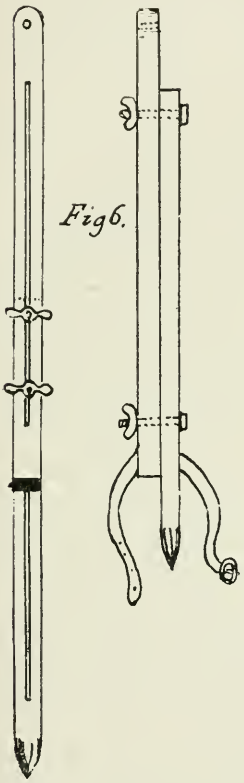


Fig 6.

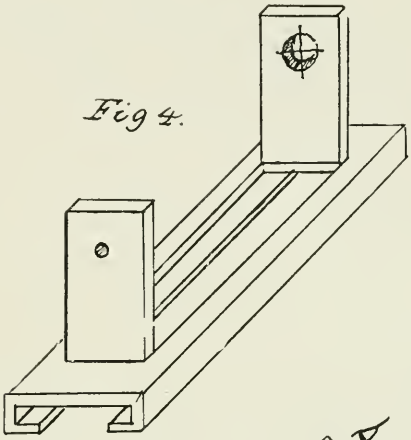


Fig 4.

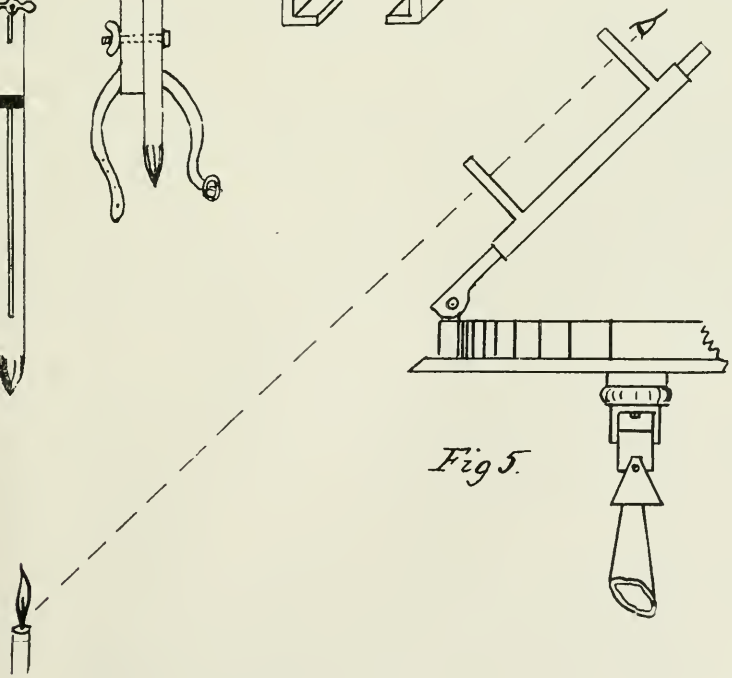


Fig 5.

this disc a female screw is tapped. "A" shows a male screw corresponding to this and by which the compass and milled headed disc "B" are attached to each other. "B" is attached but not fixed to the bent plate "C" by means of another screw passing through a hole in "C", and threaded into "B". Thus "B" with the compass attached may be turned in any direction upon the surface of "C". See Fig. 2.

The bent plate "C" is attached to the block "E" by screw "d" passing through "E" but not fixed to it. The tension of the screw is sufficient to hold "C" in any position of its range of movement The bent plate "F" is attached to the block "E" in the same way and "E" has a range of movement at right angles to that of "C". The bent plate "F" is fixed to the hollow spindle "G" which is screwed to the solid spindle of a simple tripod. It will be evident from Figs. 2 and 3 that not only can the instrument be leveled for horizontal observation; but it can also be turned into a truly vertical plane for dip readings with its pendulum clinometer.

In the position shown in Fig. 3 it is evident that an off-set (equal to the distance from the point of sight—usually taken at the end of the sights near the compass box—to the center of the top of the block "E") is made between the positions of the instrument in horizontal and vertical sights. The compass center being coincident with the center of block "E" when the instrument is set for horizontal reading. Correction may be made for this off-set, practically the same as for transits with parallel telescopes; but the error is so small that, with the limitations of the instrument, it may be disregarded.

With the above described joint and a light tripod it will be seen that I now had an instrument which was stable and by which I could take angles of elevation and depression and also horizontal ones within the range of sight possible between the top and bottom of the two folding sights, in fact in this last respect having the same range of service as the land surveyor's plain compass. But as bearings have to be taken down steep inclines something further was necessary. This was hit upon in the expedient shown in Fig. 4 and consists of a pair of sights with a peep hole in one and a round opening with cross-hairs in the other; the construction of this admits of sliding it either way upon

either of the folding sights of the compass—usually over the open or fore sight.

With this attachment in place it is possible by raising or lowering the folding sight to which it is attached to look down any depression or up any elevation.

Fig. 5 shows the application of this attachment to a sight down an incline.

In practice it is usual to take the bearing of the incline first and to establish the point, if under-ground, by a candle; the instrument is then turned over as in Fig. 3 and the angle of dip taken to the same candle, and this recorded, with, or without, the correction for the difference between the centers of the instrument in the two positions.

When the instrument is in use the slide sight is usually left attached to it, when not, it is detached and dropped into the pocket. In fact the whole instrument—with exception of the tripod, and even that with the legs off, can easily be accommodated in an ordinary coat pocket.

Knocking about in out of the way places and packing one's belongings on horse or mule back every ounce counts and every cubic inch becomes an encumberance, hence a tripod between four and five feet in length does not add to the comfort of a trip. As the legs of the one for this little compass were light they could be easily replaced; so I took to leaving them behind, depending upon the country and a jack-knife to furnish a new set, but, sometimes, "hitting the high places" straight sticks were not easily obtainable and I came to the conclusion that some kind of light extension tripod was a thing to be desired. A mine carpenter and a mine blacksmith between them constructed the device shown in Fig. 6 and it has proved a useful tool ever since and has never been obtrusive in the pack. It is not material whether the lower part of a tripod leg slides into the upper, as is usual, or lies along side as it does in this.

The construction is as follows: A strip of hard wood about an inch wide (depending upon the sockets of the tripod head) and an inch and a half deep, a trifle shorter than the ordinary tripod leg, is cut in two. Each half is then ripped through the major part of its length, say to within three inches of each end; the slit is enlarged to about 3/16

of an inch, it is on the deep side and as accurately as possible in the middle of this. The two pieces are of equal rectangular section, that is they do not taper, except the lower one which at the end is trimmed to a point and tipped with iron. Two brass screws with square heads and thumb-screws are fitted to each pair of pieces. These screws couple each pair together through the long slot and by means of them the tripod legs can be extended to their full length for use or reduced to the length of a roll of blankets.

I have had the simple instrument above described in use now for a good many years and it is still in perfect condition. The attachment of the bent plates C and "F" to the block E by the screws d appear to be the only weak point; but these parts have not worked loose and the screws have always preserved the necessary tension to keep the surfaces in sufficiently close contact for the purpose required.

The only improvement which suggests itself is that a larger compass could be substituted for the small one I use and that it have levels which mine has not. Such an instrument as Gurley describes as a "pocket Vernier compass with 3½ inch needle" would be admirable if the pendulum clinometer were added to it.

With such an instrument as this in such a case as I have cited the traverse could be run and the notes platted and the examination probably finished in less time than it would take to send word to the railway that a transit was needed; and for the purposes of the examination and report the plan would be quite as good as one made to minutes by a careful man with a high class mining transit.

Rope Driven versus Direct Driven Colliery Ventilating Fans.

By Francis T. Peacock, M.E., Montreal.

There is a difference of opinion among Mining Engineers and Mine Managers as to whether a Colliery Ventilating Fan should be coupled to the Engine direct, or driven through the medium of a Belt, Cotton, or Hemp Ropes, and the writer wishes to call attention to some of the conditions which should determine a selection of the type to be used.

The following may be taken as the principal features requiring careful consideration.

1st. Colliery Ventilating Fans must generally run continuously, night and day, including Sundays, unless of course duplicate plants are installed, enabling one to be stopped for repairs, if necessary, which, however, entails double outlay.

2nd Taking into consideration the continuous running required of this Machinery, it is of the utmost importance that the speed of Driving Engines should be very moderate, to insure freedom from breakdown. Considering the hours worked during the week, Mill Engines run only one-third the time of Fan Engines; or, in other words, each year the work done by Ventilating Engines, represents three years work, as compared with Mill or Factory Engines.

3rd. Ventilating Engines should be of the simplest design with ample wearing surfaces, as being less liable to get out of order; consequently the ordinary Slide Valves provided with adjustable cut off Valves, variable whilst the Engines are running, are particularly adapted for Fan Engines.

4th. The Engines should be arranged in duplicate, so that if a breakdown occurs in one, the other may be quickly coupled up to the Fan, meanwhile the disconnected Engine can be overhauled and again put into good working order.

5th. Both Fan and Engines should be of ample size to effect the

required ventilation easily when the Steam Boiler Pressure falls below normal, which even in the best regulated plants, will sometimes occur.

6th. Assuming that the Fan is so designed that it will easily perform its rated duty at a certain speed, the designer must consider whether it is better to install a larger Fan and drive it by means of direct connected Engines, or to install a smaller Fan, and drive by means of Ropes or Belt. This question, however, applies more to Fans of high Water Gauges and large volumes.

7th. The Plant should be an efficient one in Steam consumption, and this fact is now recognized, even at Coal Mines, where fuel is at its cheapest.

DIRECT DRIVEN FANS.

This type of Fan is very often preferred, principally, I believe, on account of its lower first cost. While a Direct Driven Fan may be considered as satisfactory for low Water Gauges and small volumes, it has a number of disadvantages for large installations, which become serious for high Water Gauges, among which the following may be mentioned.

To give the required periphery speed to the Fan, the Engine must either be provided with an abnormally short stroke, or must be run an abnormally high Piston velocity. A high Piston velocity is very objectionable in such continuous running Machinery, and it is found that the destructive effect lies not so much in the speed at which the Piston travels, as in the frequency of its change of direction.

A Direct Driven Fan must often be larger in diameter for a given duty than would be the case if the Fan were geared in order to reduce the number of revolutions and obtain the necessary periphery velocity. This means a heavier Fan, additional Foundations and additional weight on the Bearings.

There is generally considerable vibration in the Shafts of Ventilating Fans, caused in some cases by improper balancing of the Fan, and by reason of each Fan blade as it passes the opening to the outlet or chimney, being suddenly released from pressure or load. Taking the work of one day of 24 hours, and a moderate sized Fan with 8 blades running at 80 revolutions, a load of several hundred pounds, is, as it were, instantaneously removed from the blades 921,600 times.

The Shaft is consequently subjected to continual vibration, which is of course transmitted throughout the Engines, and which principally accounts for the fact that an Engine driving a Fan direct coupled of only moderate size, is almost invariably subjected to a hammering or knocking in its Shaft Bearing, Crank and Crosshead Pins, requiring a frequent adjustment of the working parts.

The breakages of large Fan Shafts, which have occured in Europe, after their elastic limit has been reached and the loosening of Bolts or Rivets in the Fan proper, are attributable to this vibration.

In Direct Driven installations, there are usually three Shaft Bearings, one on each side of the Fan proper, and one for Engine Crank Shaft There is a difference, not only in the dead weight, which these Bearings have to support, and consequently a difference in the amount of wear, but they tend to wear in different directions, and in consequence it is a most difficult matter, if not practically impossible, to keep all Bearings in proper alignment, and prevent knocking. This feature is not improved by reason of the natural deflection of the Fan Shaft, which is also liable to affect the alignment of Engine Crank Shaft, and consequently, the Crank Pin.

A Single Engine is of course not economical, as compared with a Compound Condensing Engine, and before the introduction of the Rope Driven Fan in England, it was customary in large or important installations, to equip the Fan with a Direct Driving Tandem Compound Engine on one side, and a Single Engine on the opposite side of the same end of Fan Shaft, with its own connecting rod connected at Crosshead end, the Crank end being suspended ready to attach to the Crank Pin in case of an accident to the Compound Engine. The Fan is in this manner provided with two separate Engines, with the exception of the Crank Pin. If this should break or become loose, the Fan must stop.

One of the advantages of the Direct Driven Fan in addition to its lower first cost, is that it requires less room and a smaller Engine House. This, however, is not always important, for the reason that the Engine House may often with advantage, also contain other Machinery, such for instance, as an Electric Lighting Plant.

As the writer has previously pointed out, Direct Driven Fans are suitable, and often satisfactory, for low Water Gauges and small volumes. When this system is adopted, however, VERTICAL, and not HORIZONTAL Engines are preferable for the reason that the Vertical type of Engine will better withstand the higher Piston velocities, vibrations and strains to which all Direct connected Engines are subjected.

BELT DRIVEN FANS.

Belted Fans are objectionable, except for very small capacities or temporary installations, on account of their liability to give trouble and annoyance with Belts stretching or breaking, when applied to this class of continuous running Machinery.

ROPE DRIVEN FANS.

This system of driving Ventilating Fans, now long in use in England, has for the larger and more important installations of that Country of deep Mines and intricate Ventilating problems, taken the place of the Direct Driven system, especially for high Water Gauges and large volumes. Rope Driven Fans have the following very obvious advantages :—

The Engines can be run at a very moderate speed, and long strokes can be adopted, thus considerably lessening the frequency of change of direction of the reciprocating parts, consequently adding length of life to the Machinery and minimizing the liability to breakdowns or stoppages.

The Fan being driven through the medium of separate Endless Cotton Ropes, (usually 1⅝" or 1¾" dia.) any vibration in the Fan itself, and the somewhat impulsive action of the Engine is practically dissipated through the elastic medium of the cotton ropes. Assuming the installation is geared at about 2½ to 1, the Engine passes over its dead centres only ⅖ as often as in the case of a Direct Coupled Engine, and in the case of Twin or side-by-side Compound Engines, with Cranks set at right angles, the Driven Pulley receives only a comparatively light impulse at each four points in a revolution, instead of a heavy impulse at each two points in a revolution, all of which conduces to very smooth running, long life, and a minimum cost for repairs.

The Fan Shaft runs in its own Bearings, independently of the Engine.

It is sometimes found that after a Fan is installed and has been running for some time, it is very desirable, owing to the varying circumstances of the Mine, to change the velocity of the Fan. Such a change, within certain limits, can readily be affected in Rope Driven Fans by changing the diameter of the Driven Pulley on the Fan Shaft. This is a great advantage of this type of Fan, and has often been taken advantage of by Mine Managers and Engineers.

In the case of Single or Tandem Compound Geared Engines, there is of course only one Crank Pin, as in the case of Direct Driven Fans, but when the Engines are of the Twin or side-by-side Compound type, and they are provided with a system of Valves to allow of the high pressure or low pressure side running alone or independently and of live steam being admitted to the low pressure Cylinder, which is provided with a relief and reducing Valve, we have two Crank Pins and practically two Engines, so that if an accident should happen to the H P. side, the L. P. side will temporarily drive the Fan, and vice versa. It is of course true that one side of the Engine will not drive the Fan to the same capacity or as economically as the Compound Engine, but if the Plant is properly designed, so as to easily perform its rated duty, one side of the Engine will drive the Fan to so nearly its full capacity, that practically little or no convenience results in so driving, temporarily.

It may be considered an objection to introducing the Rope Drive between Fan and Engine in that, by so doing, an additional factor of uncertainty is added in the Ropes, and that some power is wasted in Rope Transmission. In answer to these objections, experience has proved that by carefnl selection of the best makes of Cotton Ropes, and proper attention, they will run continuously for years without giving trouble. If one of the Ropes should give away, (which is a very rare case if the load which each Rope is designed to carry is not too great, and ordinary care is taken), the Fan can be run by the remaining Ropes until such a time as another Rope can be spliced and applied.

With reference to the power wasted in Transmission, with Pulleys

of proper size there is practically no slip of the Ropes in the grooves, and with well designed and well finished grooves, the power required to bend the ropes around the pulleys and to pull the Ropes out of the grooves as they leave the Pulley, is so small that it can be practically almost neglected.

One of the advantages of a well designed and well constructed Rope Driven installation is, that on account of the moderate speed of the Engines and comparative freedom from vibration, less expense is required, not only for repairs and adjustments, but also in the smaller amount of lubricating oil used.

The object of this paper is to call attention in a general way to the advantages and disadvantages of the different methods of driving, only, though I hope to supplement this paper with others dealing with Ventilating Machinery, which is of such vital and increasing importance to modern Colliery Plants.

Treatment of Auriferous Mispickel Ores.

By P. Kirkegaard, Deloro, Ont.

Introduction.

The ores of the Deloro Mine consist generally of quartz more or less heavily impregnated with arseno pyrite, "mispickel," with occasional copper pyrite and frequently a large percentage of iron sulphide.

These ores are worked for their gold and arsenic contents.

Above description applies to the Gatling or main lode, and also the Tuttle lode.

Other veins are being worked, which are quite different in composition, in that they contain large percentage of both oxide and hematite of iron, and in one case a great deal of graphite, and these latter ores require different treatment from the former to get best results.

This paper is only intended to cover the treatment of the mispickel ores.

These ores are mined in the usual manner. Where possible, the shafts are sunk to follow the lode on the incline and levels are driven north and south.

The strike is nearly north and south, and the dip varies from 45° to 63° to the horizontal.

The lode is irregular, varying in size from 4 to 5 feet, "the average," to 25 feet in places.

There are no defined walls; as a rule the quartz is merging into the wall rock, which is in some places talcose schist—in others diorite, the latter being the country rock.

The Gatling lode is now being worked to 4th level, being a depth of 340 feet on the lode, and sinking a further 100 feet is now being done, to open a 5th level.

Hoisting and Sorting.

The ore is hoisted to the shaft house in skips, dumped over a grizzley, the fines going direct to storage bins and the coarse carefully culled.

As a rule the white quartz carries little value,—hence this and all country rock is returned through a chute to the mine, where it serves a useful purpose as filling in the stopes.

Transportation.

All milling ore is passed to storage bins; from here it is filled into cars and transported to mill, over an inclined three rail tramway, 800 feet long.

Crushing.

Arriving at mill the ore is again dumped over a grizzley, fines going to bins, of which there are two, and the coarse to the rock breakers; the latter being set to crush to one inch ring. The feeders are the usual Challenge pattern, two ordinary in wood frame and two suspended.

The stamps, of which there are twenty, weigh 850 pounds each when newly shod

Ten stamps were erected in 1898; the other ten have been added recently.

The old ten stamps drop 100 times per minute and are given 7 to 8" drop; the discharge is from 6 to 8".

After running a mill two years on any ore, improvements naturally suggest themselves, so in this case, when the last ten stamps were added, they were set to drop 110 times a minute with 6" to 7" drop, and corresponding discharge. This has proved to be a move in the right direction, and has increased the efficiency above the old ten stamps; these latter will be set to the same speed shortly.

Water Feed to the Mortars.

The water feed as described by Mr. Bernard MacDonald, before the Canadian Mining Institute, has been introduced, and this, at least for these ores, is an advantage.

Mr. MacDonald's description of this method of feeding water to stamps has been followed in all the main features,—the only real deviation therefrom being that the inlet is raised 3" higher than he describes.

The writer is aware that this method of water feed has been criticised severely by some very able contemporaries, yet in the face of this he does not hesitate in stating that for an ore similar to the one in question it has much to recommend it, nor can he see any reason why it should not give continued satisfaction, and even less trouble than the old method of feeding the water above the stamps. Mr. MacDonald deserves the thanks of the fraternity for having so ably and fully described this stamp battery water feed.

Screens.

The screens used are 40-mesh bur slot. These are watched closely as soon as they begin to open other screens are put on, and those taken off are closed with a little hammer specially made for this purpose, and in this way the same screen will do five to six turns of two and three days each, giving a fairly uniform product, well suited for leaching. Crushing through 40 mesh has been found to give best results; taking a sample of the battery pulp, nearly all the mineral will pass through a 60 mesh screen leaving the quartz on the screen.

The crushing capacity of this mill has been with the first ten stamps a little over 3 tons per stamp per 24 hours, or an average of 800 tons per month. The improvements on the new stamps have brought the capacity up to 4 tons per stamp.

Amalgamation.

Amalgamation inside of mortars is done on back plates and front chuck; the former is kept partially under the pulp and is protected by another plate 1½" above it, the chuck block is the usual shape.

Most of the amalgam is caught on the back plate, where it forms into hard lumps and ridges.

Very little loose amalgam is found on the mortars on clean up, and no coarse gold worth considering.

Great care is necessary in feeding mercury to the mortars,—a slight excess will soften the amalgam, when it is quickly scoured off by the very dense pulp, is broken up, and then issues through the screen in a very dirty state and is lost as far as amalgamation is con-

cerned; in such cases it is, however, caught with the concentrates either in the trap or on the concentrators and finally saved in the leaching.

Too little mercury soon allows the amalgam on inside plates to become dry and hard, and a dirty film forms, when all further amalgamation ceases.

Owing to the extreme care necessary as above described, and the varying character of the ore as regards per cent. of Mispickel, and quantity of gold amenable to this method of amalgamation, no exact data can be giveu as to per cent. saved inside the mortars; but 20 per cent of the total assay value in the ore is fairly approximate.

Amalgamation on the apron plates must also be watched with unusual care, or the plates will soon show a dirty film, due in part to the fine Mispickel, which inclines to adhere to the plate like a paint, and which requires force to remove it.

The plates are six in number,—each 24" in length by the full width of the mortars and there is one inch drop between them.

The plates are set with an incline of 2¼" per foot; this is necessary to keep them clear, and even at this steep angle they will frequently clog.

As little water as possible is used so as to obviate the rapid motion of the pulp that naturally would occur over such a steep plate, and also to save the concentrators from an unnecessary amount of water.

The amount of water as compared with ore is necessarily greater for an ore of this kind than would be needed for an ordinary free milling ore. Heavy silver plating is best for this kind of ore; it has been found, that as soon as the silver is worn thin, the copper will show tarnish. This can be counteracted by building over it with gold; but gold in this case does not form as desirable an amalgamating surface as silver; the former will become hard and dry and soon ceases to work, whereas silver will retain a plastic surface. Owing to this, 4 oz. of silver per square foot of plate has been adopted, and with care in dressing the plates, this coating will last almost indefinitely. No cyanide is used except in extreme cases, such as after a long

stop or when ores containing much free iron is being milled, in which case spots very much resembling grease will form all over the plates; these are best removed either by a weak solution of cyanide or preferably a little caustic soda. The plates are dressed every two or three hours, according to need; this dressing being done with a rubber consisting of several layers of soft wool blanket fastened on a wooden paddle, and this rubbing is followed by a brushing with a whisk.

Under normal conditions, *i. e.*—when milling the regular Mispickel ores, a saving of from 50 to 62% is effected by amalgamation in mortar and on plates; the average for several months being 57% of assay value.

The gold is occasionally found free and fairly coarse, but this is the exception, close investigation having shown, that the gold is locked up in the Mispickel and in a very finely divided state; it is therefore necessary to crush fine to at least partially liberate this fine gold to fit it for amalgamation and subsequent leaching by Bromo-Cyanide.

Concentration.

The pulp on leaving the plates is passed through a suspended screen, hanging under lower end of table; here all stray pieces of coarse pulp that might escape from the mortars, when changing screens, are caught.

Below the screen and before reaching the concentrators, the pulp is made to flow through a trap; here any stray amalgam is caught.

These traps "one for each battery" of 5 stamps are cleaned out every 12 hours, the contents panned down and closely observed, and this serves as a good indicator of the work done in Mortars and on plates, and precautions are taken accordingly.

This may, in fact, be compared with a doctor feeling the pulse of his patient. The pulp from the old stamps passes over 6 feet corrugated belt Frue Vanners, one for each 5 stamps.

The tails from these two Vanners join in one launder and are allowed to flow into a series of hydraulic classifiers, 3 in all; here a partial separation is effected, and three grades of pulp are thus ob-

tained, viz: coarse, medium and fines. Each of these products is run over a 6 foot smooth belt Vanner, and each of these Vanners is adjusted as to speed, inclination, travel and wash water, to suit the particular pulp flowing over it; in this way a very close saving is effected.

The average tailings from these second set of Vanners carry only 2 to 2½% of the original gold, and 0.5% of the Mispickel contents of the milling ore. The concentrates from the first two Vanners forming the bulk or approximately 75% of all concentrates produced, are shovelled into cars, together with those produced by the second set of vanners and thus become mixed.

The concentrates from two of the last named Vanners are very fine slimes. No water is allowed to leave the Mill, except what has passed over the Vanners. It was soon found, when stamps were first adopted under the present system, that the water, even when apparently free from sand, still carried a high value both in gold and per cent of Mispickel.

This loss has been checked very effectually by classification as above described, and by carefully adjusting each Vanner to suit the class of pulp passed over it. For the new section of the mill, Wilfley tables have been adopted,—one for each 5 stamps; the tails from these flow through one classifying cone, where all coarse sand is extracted and with a limited amount of water flows to a three deck Bartlett Table.

The surplus water from the classifier, still carrying some fine sand and all the slimes, flows to the three compartment classifiers and is treated with similar pulp on the smooth belt Vanners.

All concentrates are transported in side-dumping cars, to the leaching plant, where they are treated by the Bromo-Cyanide Process.

This part of the treatment I shall leave for my colleague, Mr. S. B. Wright, to describe, he being the chemist in charge of this department.

Special Features.

As special features or innovations from ordinary practice in milling of ores by stamps, the following may be cited :—

A high speed engine "Robb-Armstrong" tandem compound, is used, running at 235 rev. per minute.

This engine, together with the boilers, are in a separate building, and 40 feet from the mill building proper. The power is transmitted by a 4 inch shaft to the outside of the mill building, alongside which is a tunnel, through which runs the main belt connecting with the main countershaft of the mill.

The advantage of a high speed engine is a constant uniform speed for the stamps, which is a most important point. In the same building with this engine is another but smaller Robb-Armstrong engine, driving an alternating current generator, which is furnishing light for the whole plant.

All the concentrators are driven by a separate engine, and are thus independent of the rest of the mill machinery.

Starting at the top of the mill, may be mentioned the rock breakers, being set to crush very fine, thereby greatly aiding the stamps.

The high speed of the stamps with comparative short drop, gives a lively and continuous wave in the mortars and greatly assists the discharge of the heavy mineral.

The water being fed from the back and on a level with the dies also aids the discharge. Protecting the back plate may also be worth noting.

Using burr slot screens for greatest output which the writer believes is contrary to what is generally conceded.

The explanation in this case is that the pulp being very heavy, will keep the mineral particles suspended when thick, and will discharge uniformly when partially checked by a burr screen, hence the mineral has less chance of settling below discharge level, than if a free discharge was given such as a wire screen would afford.

Through the latter the thin pulp would flow more readily but would leave the heavy mineral behind to be still further crushed under the stamps.

Passing all pulp from the plates through a screen has an important bearing on the subsequent results of concentration.

The traps are not of much importance as amalgam savers—their chief value is as indicators of the work that has been done before the pulp has reached that point. This may only be true on ores of this class.

When pulp is normally of even mesh, say 40 mesh down to fines, the particles will concentrate together fairly well, but if a few particles of coarse material, such as will escape from the mortar when a screen is removed, be present also, each of these particles will stir up a turmoil on the concentrator and continue the agitation immediately around itself throughout its whole travel to the tail end, and will carry a corresponding amount of mineral with it, which would, had there been no such agitation, have been saved with the heads.

The importance of avoiding undue agitation when concentrating an ore much inclined to form slimes carrying high values is self evident.

Double concentration is very essential on these ores, no single concentrator would give clean tails.

Classification of the pulp between 1st and 2nd set of concentrators has a most important bearing on this after-treatment, in that it permits different adjustment to suit the pulp flowing over each particular machine, which could not be done to advantage on a mixed pulp.

The tailings from the second set of concentrators joins in one launder for each section of the mill leading out of the mill, but just before leaving the building these tailings are sampled by an automatic sampling machine acting as follows :—

The flowing pulp gives impulse to a little breast wheel suspended over the launder, this motion is communicated through gearing to a reciprocating arm, upon the end of which is a cup or spout.

This cup is made to pass across the stream automatically at regular intervals, "every 10 minutes," when it cuts out a very small but absolutely representative portion of the whole stream; this forming the sample, is led into a tub and allowed to accumulate for 12 hours, or the full shift.

This sample is collected for assay at the end of each shift, and thus serves as a check on the work done by the concentrators.

There is a sampler for each ten stamps—any trouble or careless work being thereby readily located.

It will readily be seen that careless work on the part of the workmen in the mill is at once detected, and taking the average of the tails sample, together with that of the ore sent to mill, it becomes easy to calculate what the mill is doing.

Construction.

As special features in construction may be mentioned the A battery frame.

This was ably described by Mr. R. W. Barrell in *Mines and Minerals* for November, 1899.

Mr. Barrell, however, failed to give the writer due credit for having developed this battery frame to its present state of perfection.

The writer has built this style of battery frame on several occasions, and can say without hesitation that it forms a most excellent frame, one that will stand the continued vibration of the stamps without detriment to itself.

The tables are 12 feet long and made in six steps of one inch drop between each.

These tables are securely fastened under the lip of the mortars and held to the battery frame by angle irons; the lower ends of the tables are resting in the tail box, which in turn is hung from the floor.

There is no intermediate support. This long span without supports is purposely made to permit the vibration from the stamps to be communicated to the plates, which is an advantage where pulp is made to flow rapidly over copper plates.

The milling plant is built in four distinct and separate buildings, viz: the power house built of brick and as already referred to, 40 feet away from the mill.

The stamp mill with its ore bins, and all concentrators.

The leaching plant below the stamp mill, but separated by 20 feet; this was done to prevent any vibration from the mill being com-

municated to the leaching tanks, the ore being very heavy and dense, could not stand anything that would tend to further compact it in the vats.

And finally the assay office and laboratory, which is 40 feet from the leaching mill and 20 feet from the power house—the four buildings forming a square.

This makes a very compact and convenient plant, and at the same time keeps each department distinctly to itself.

By Product.

The concentrates, after the extraction of their gold contents, are sent to the Arsenic works, where they are calcined for the Arsenic they contain.

The crude arsenic resulting from the calcination is in turn refined and produces white arsenic, "arsenious oxide" analyses—of which show 99.4 per cent. to 100 per cent. pure $As_2 O_3$ and is of a pure white color.

This is the only arsenic producing plant on the American Continent, manufacturing arsenic on a commercial scale. The production is 40 to 50 tons per month and this will be further increased shortly.

To fully describe all that has been tried and the many difficulties that have been overcome, one after the other, would be too lengthy and would not interest anyone—suffice it to state that, many of the little schemes seemingly trifling in themselves nevertheless when taken as a whole and in conjunction with the Bromo-Cyanide Process constitute the secret of the successful treatment of these very refractory ores to-day.

Leaching Copper Ores by Sulphurous Acid.

By E. P. Jennigns, Salt Lake City, Utah.

The writer has had occasion in the course of his professional work to investigate a unique process of leaching copper ores by the use of sulphurous acid, which has been patented in the United States by James W. Neill, of Salt Lake City, Utah.

The process, while yet in the experimental stage, has a number of valuable features which will make it of interest to members having deposits of copper ore remote from transportation, fuel and fluxes.

The native oxides and carbonates of copper are readily soluble in sulphurous acid with the formation of cuprous sulphite ($Cu._2 S O_3$). This salt is insoluble in water, but soluble in water containing sulphurous acid from which the copper can be precipitated by driving off the excess of sulphurous acid by heat. The precipitate is cupro-cuprous sulphite ($Cu. S O_3$, $Cu._2 S O_3 + 2 H_2 O$) and contains 49.1% of copper. This salt is heavy, crystalline compound of a dark red color, which settles readily from the solution and can be washed by decantation, dried and reduced to metallic copper by fusing on the hearth of a reverberatory furnace.

The process is suitable both for sulphide and oxidized ores the former being first roasted to expel the sulphur and convert the copper compounds into oxides, as sulphurous acid does not attack sulphides.

The ideal ore is one carrying oxides or carbonates of copper in a silicious gangue; lime and magnesia are objectionable, as they dissolve in sulphurous acid and, while they do not materially interfere with the reactions, they consume a certain amount of sulphur and so increase the cost of the process.

In practice the ore is crushed to pass a 20-mesh screen, placed in covered tanks filled with water containing sulphurous acid and kept in a state of agitation by forcing a current of sulphurous acid from the gas generators through the solution; this brings each particle of ore in contact with the acid and also keeps the water saturated with sulphurous

acid gas. All the copper will pass into solution in from one to four hours; depending on the physical condition of the ore.

The charge is now drawn into a settling tank, the sands allowed to settle for a few moments, when the solution, which carries more or less slimes, is decanted into a filter press that separates the solution from the slimes and forces it to the precipitating tank. The sands in the tank and the slimes in the filter press are washed once with sulphurous acid, which is afterwards used in the treatment of the next charge.

The dissolving tanks are arranged in series, one above the other; the gas entering the lower one and passing through each one in turn, any excess being at last absorbed in a condensing tower.

The precipitating tank is supplied with a steam coil through which the exhaust steam from the crushing plant is passed, thus heating the solution and precipitating the copper as cupro-cuprous sulphite which settles rapidly to the bottom of the tank. The solution from this tank is run into another tank while still hot and freed from small amounts of copper that is in solution as sulphate by means of a little lime.

The precipitates are dried and smelted to fine copper.

The plant can be so arranged that nearly all the sulphurous acid except that combined with the copper can be saved and used again.

One pound of sulphur is required to convert four pounds of copper into sulphite, and another pound of sulphur will keep the cuprous sulphite in solution, but the greater part of this second pound of sulphur can be recovered. In practice about one pound of sulphur is required to treat three pounds of copper contained in the ore.

The sulphurous acid is produced either by burning pyrites or sulphur, the former can be obtained in most mining districts and the latter occurs in great beds in Utah. When the original ore is a sulphide, it will furnish, by roasting, ample sulphurous acid for its own treatment.

The advantages of the process over the sulphuric or hydrochloric acid method are: first, cost of the chemical is low; second, it is generated on the spot by the use of a very simple plant; third, a relatively small amount of the chemical is used; fourth, the copper separated

from the solution by heat alone ; fifth, the copper produced is practically free from impurities.

Sulphurous acid produced by roasting pyrites is the cheapest chemical procurable in the western country and the plant is much simpler than that used in making sulphuric acid.

A unit of copper converted into cuprous sulphite requires but half the sulphur that would be required to convert it into cupric sulphate.

Cuprous sulphite is precipitated from the solution without the use of scrap iron, which is a great advantage in remote districts. In southern Utah for instance, scrap would cost from $40.00 to $50.00 per ton and from 2 1/2 to 3 1/2 pounds of iron ore required to precipitate one pound of copper from sulphuric acid solutions owing to the large amount of basic salts formed.

Sulphurous acid dissolves very small amounts of other metals that may be in the ore and the precipitated cupro-cuprous sulphite is practically pure and furnishes pure copper by a simple smelting operation.

In experiments made by the writer on ores of the Triassic Sandstone of Northern Arizona, 95% of the copper was extracted by leaching the ore for four hours, the ore was a mixture of blue and green carbonates with some oxide disseminated in sandstone ; the grains of which were firmly cemented by a secondary deposition of silica making the rock harder to crush and much more difficult to leach than an open grained sandstone would have been, as the little particles of copper were coated with silica.

The experiments demonstrated the feasibility of the process with this kind of ore, and a plant will be erected in the near future for the treatment of the ores of the Coconino Plateau.

Across the Pitch versus Up the Pitch.

(*Continued.*)

By O. E. S. Whiteside, Anthracite, N. W. T.

In concluding a short paper written for our Annual Meeting in March, 1899, and entitled "Across the Pitch versus Up the Pitch" I suggested the possibility of a continuation later on.

Summing up the arguments advanced in this paper, and arriving at a general conclusion, I would say that the former is to be preferred in seams containing any amount of refuse that ought to be gobbed inside the mine; and the latter for seams containing little or no refuse, or where the whole product of the seam is to be shipped to the surface, and more especially if the seam is a thin one. In some instances there will be exceptions to this rule however. If it is absolutely necessary that pillars be left standing, it is possible that a fairly dirty seam should be worked "up the pitch"; while, on the other hand, if it is impossible to get miners used to that class of work, it would then be necessary to work a very clean seam "across the pitch" even though it were a thin one.

A seam containing in descending order:—

	FEET.	INCHES.
Mining	0	6
Coal	2	0
Slate	1	6
Coal	4	0
Mining	0	6
Total	8	6

and pitching at 35° to 50° ought, according to the general rule, to be worked across rather than up the pitch; while one containing in descending order:—

	FEET.	INCHES.
Coal	3	1
Mining	0	3
Total	3	4

ought to be worked more profitably straight up the pitch.

In the first example it would be much better, in the majority of cases, to adopt a system lending itself readily to the gobbing of waste inside, and this could not be done either so well or so cheaply if worked "up the pitch". In the second example the very small amount of waste gives ample mining, and is easily taken care of while driving to the rise, and, furthermore, being so thin it would be impossible to get a breast-car of any size in to work it, by the other system, without shooting rock. This could not be the case in any dirty seam containing enough coal to be workable.

Coming to the work in the broken the first requisite to the successful continuation of "Across the Pitch" work is to follow up immediately by pulling the pillars. If the coal is hard and does not contain many slips, and there does not happen to be another seam close by, these pillars may stand for a considerable period; but before the boundary is reached, even in a very small mine, they are sure to commence dropping coal on the low side, and once this starts it is a very short time before a great deal of coal is buried and lost, and the pillars left in very bad shape for pulling. If the seam is a thick one the effects are more marked, and, if a thin one, the roof and floor come so close together in the breasts worked out that, in order to get a breast-car in on the low side of each pillar, rock work has to be resorted to. This in conjunction with the opening of old chutes caved in, may make the pillars cost more than the work in the solid, while the percentage of waste will be greatly increased if the broken work does not immediately follow the solid.

Pulling the coal advancing requires little or no extra expense on chutes already in for the solid work; the roads are easily gotten in to the back end of each pillar; and the pillars are in an easy and safe condition for mining, but it is of course absolutely necessary that air holes be kept to the surface, or return air way in advance of the pillar pulling, and in troubled ground like that generally met with in the class of mining here referred to, these are often expensive items.

Throughout these operations the pillars should be pulled in regular steps the upper ones in advance of the lower, but not far enough to produce falls of rock that would cover the ends of the lower pillars and

thus shut off the ventilating current. The coal from the breasts is of course all dumped into what is termed the outside chute, but that from the pillars should be put in the inside chute.

The track for the breast-car is laid on the high side of each breast on top of the "Gob" and just below the pillar, and, when the end of the pillar is reached, the coal is attacked and taken back, the distance to push the coal becoming less and less until the pillar is completely out.

In badly troubled ground the air-holes kept in advance of the pillar-drawing will not always be straight up the pitch, as it will often happen that the shortest way through the fold will not be directly to the rise, and, on this account, it is often necessary to modify the system previously adopted, in the vicinity of certain folds.

The three systems of work adopted in the thin coal seams of Belgium "gradins renverses", "tailles montantes" and "tailles chassantes", are merely variations of long-wall work adopted on account of the thinness of the seams, but, in so far as the direction of the working face is concerned, they include "Across the Pitch and Up the Pitch" work.

The first and third are across the pitch while the second is to the rise The second and third cover fully the two systems I have previously described, both as regards the direction of the working face and the pitch of the seams, yet the question of the thickness of the seam, or the amount of waste contained in it, seems to have been a secondary consideration to the degree of pitch in the evolution of systems, probably because their seams are more uniform in thickness and also in the amount of waste they contain. The degree of pitch is certainly a very important feature in the choice of a system, for, if it is heavy, the coal from the face falling on the waste below (if there is any) is lost to a considerable extent, and, as I pointed out before, especially is it important if the miners are not skilled in that class of work.

In the highly inclined seams of Pennsylvania and the Pacific Coast the miners are exceedingly skilled at this class of work, and many of them prefer to drive up the pitch no matter how steep the inclination may be. In the state of Washington they also invariably drive to the rise partially for this reason, and partially on account of

the fact that many of their seams (containing enough dirt to recommend "Across the Pitch" work) are so soft, and at the same time lively, that "Across the Pitch" pillars cannot be kept in, even while the solid work progresses.

On a very easy pitch of from 12° to 30° the Belgians drive up the pitch and, as a rule, on slightly heavier pitches of 30° to 45° they drive across although the latter is used in some instances on pitches varying all the way from 0° to 60°. The system entitled "gradins renverses" is similar to overhand-stoping of metal mines and is adopted on the heavier pitches of from 45°to 90°.

In several instances in the state of Washington they have adopted a system for seams pitching from 45° to 90° which is neither across nor up but "half on" and locally termed the "Chute and Pillar" or "Diamond" system.

The gangways are driven first in the direction of the strike, and the chutes straight up the pitch, far enough to form gangway stumps are connected at the top by horizontal cross-cuts. From here up these chutes are continued not straight "up the pitch" but "half on" so that, on a seam pitching at 90°, the pitch of the chutes would be 45°.

These angle-chutes, as they are termed, are connected at intervals by angle-cross-cuts driven at right angles to the angle-chutes, their pitch being also 45° on a seam pitching 90°, but in the opposite direction to the pitch of the chutes. All these places are driven narrow and generally so as to form square pillars diagonally across the pitch, thus getting the name "Diamond"system. While the newer angle-chutes are being driven, the older ones immediately behind are being widened out and cogs placed on both sides, the work being started at the top and continued downwards, and the pillars immediately behind these are being pulled and the upper ones first.

The chutes are either driven to the surface or to a counter-gangway and the timber needed is lowered down them. Under certain conditions this system is an excellent one, and the coal gotten out very cheaply: but it can only be used advantageously when the breakage of the coal is of little account and where it is not necessary or feasible to store waste inside the mine.

If the coal is to be converted into coke, and the refuse of such a nature as to be best taken care of by means of a washing plant, it is an exceedingly profitable system.

It is very much safer for the miner than "Up the Pitch" work, and there is no extra labor in the cross-cuts shoveling coal, their pitch being thes ame as that of the chutes, all the coal mined gravitates to the gangways.

The size of the pillars and the number of cogs necessary are mere matters of detail to be determined by local conditions, such as the strength of the walls the thickness of the seams &c , &c.

To illustrate
J. G. S. Hudson's
Pape on Shipping
Coal
at Port Morien
C.B.
Government Breakwater
Main Street Town of Port Morien

Shipping Coal by the Aerial Wire Rope System at Port Morien, Cape Breton.

By Joseph G. S. Hudson, M.E., Port Morien, C. B.

The designer of the aerial wire rope tramway, Mr. Roe of the Ropeways Syndicate of London, claimed for his system: that it was easily installed, economical in working, simple in operation, easily maintained when erected; and that it could be adapted to almost any practical working condition and that for the tons of material, it was capable of handling, the first cost was very small compared with the usual means of transportation.

In working the system we have found the designer's estimate correct and in the words of a gentleman who visited our works, recently, and who had a similar problem to solve "It is just the thing."

On the map shewing Port Morien harbour and where Gowrie and Block House Collieries, Limited, of Newcastle-on-Tyne ship their coal, it will be seen that the wharf marked Dominion Coal Co. pier extends out from the shore, to a point where the vessel had sufficient water to take in cargo practically one thousand feet from the shore at high water mark.

To attain this mark and build a wharf by the means, customary use in the district, meant at a very conservative estimate $25,000, allowing that the minimum depth of water at low tide was to be 14.0 feet, and from this point the wharf would have to be extended sufficiently for ocean steamers to load.

By adopting the aerial tramway system you commence your shipping pier in the depth of water you wish to obtain for vessels, can place support towers from 325 to 375 feet apart, between given points, and bring your wire ropes to the point where your coal is delivered from the screens, and so save to a very great extent, a large expenditure in labour and material in building.

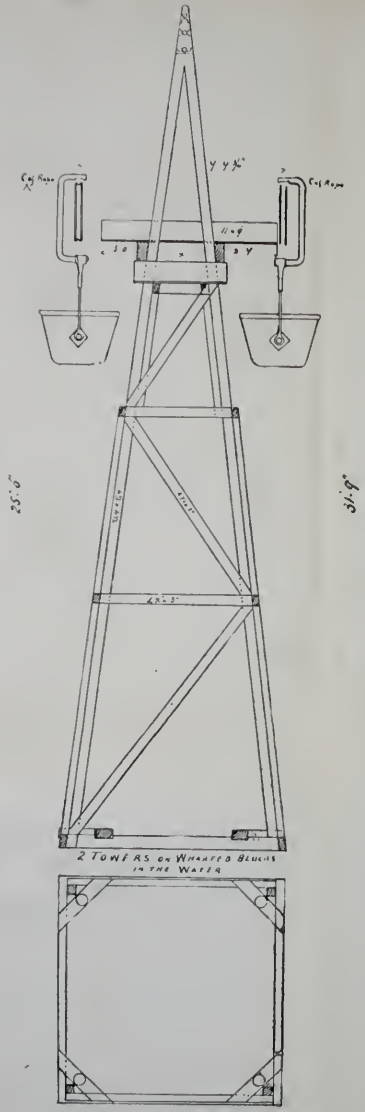
Commencing at the loading station we have a small Jenckes engine with cylinder 9 inches in diameter and 12 inches stroke with a

fly-wheel 42 inches in diameter, on this a four-ply 8 inch rubber belt on a 42 inch Dodge split pulley, which drives a two inch shaft to a geared bevel wheel 5 feet in diameter, which is placed horizontally on a 6 inch perpendicular shaft, immediately below is the rope wheel feet in diameter. The driving shaft making 14 revolutions per minute, this is nominally the motive power. The rope is one inch and one eighth in diameter ordinary Lang laid.

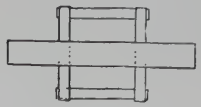
The driving wheel is situated at the near end of the loading station, in order to allow the shunt rail to extend further back than the loading point, so that sufficient room can be obtained to allow the empty buckets to come on the shunt rail, and radiate to the loading point and have enough space for standage room between the empty and full buckets. The terminal stations are built of 4½ inch by 9 inch scantling, uprights in concrete foot blocks. Bents 9 0 feet centres and 7.6 feet high on which is suspended by cast iron hangers a piece of steel 3½ inches deep by ⅝ inch thick; these pieces form the shunt rail. The carrier is so designed that it forms a clip on the rope, and is also provided with two wheels 6 inches in diameter, which come into operation when the buckets leave the rope at the terminal points, and are transmitted with the rope impetus to the shunt rail, both at the loading and unloading stations.

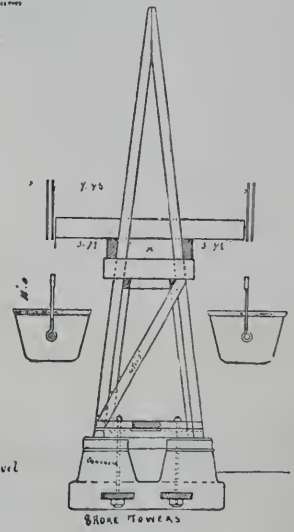
The buckets are of pressed steel and carry 850 lbs. of coal. It has been demonstrated by practical working that an excessive weight in the buckets causes a much heavier and expensive plant, and that the better method is to move a small load quickly and often than a heavy load slowly; for example it was the original idea to have 5-ton loads, but now it can be demonstrated that ten buckets will carry five tons nearly in the same time and can be distributed a bucket every 200 feet along the entire length of rope, and attain the same quantity of material carried in the same given time.

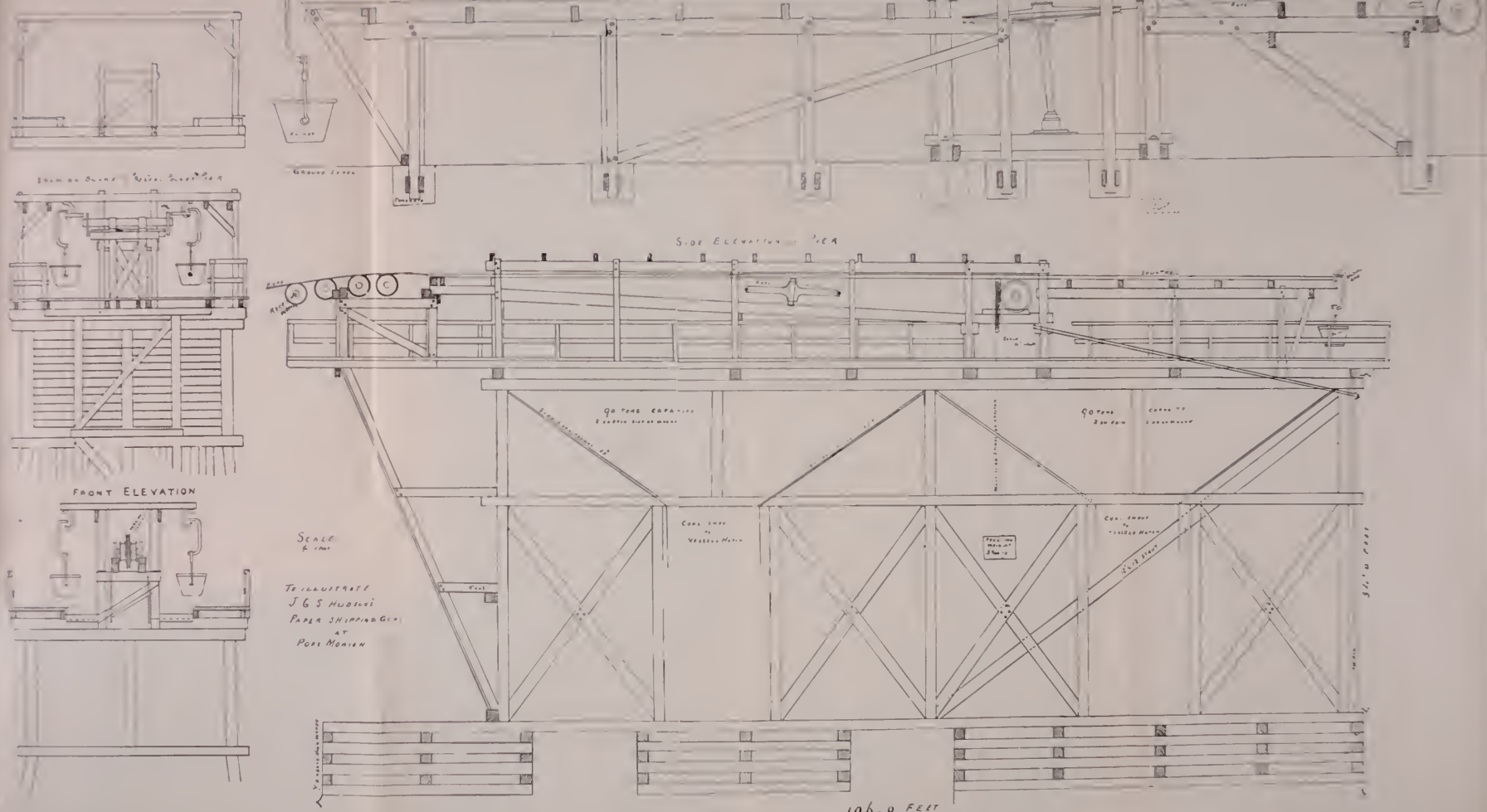
When the bucket is filled at the loading station, the operator simply gives the loaded bucket a shove, the wheels on the carrier running along the shunt rail until it comes in contact with the moving rope, which conveys it along at the same speed as that which the rope is moving. One hundred feet from the loading station is a tower 11.0



To illustrate
J. G. S. Hudson's
PAPER on the METHOD
of SHIPPING COAL
GEMMELL and BLENKINSOP Collieries
PORT MORPETH
C. B.
Scale 8 feet to 1 Foot






FRONT ELEVATION
SCALE
To illustrate
J G S Hudson
Paper Shipping Co.
at
Port Morien
106.0 FEET
25.0 FEET Base

feet high with a cross arm of sufficient length to spread the rope apart, so that the loaded bucket going out on the full rope will not come in contact with the empty bucket returning on the other rope travelling in the opposite direction on which the empty bucket runs.

On all these towers are suspended by means of self-moving bracket arms four wheels in line on the full side and two wheels in line on the empty side.

These wheels are so balanced that they dip down to accommodate the sag of the rope when the bucket approaches the support tower, and make a return dip, when the buckets go with the sag of the rope from tower to tower.

When the loaded bucket arrives at the pier, by looking at the side view of the pier, it will be seen that a platform extends out over the end of the pier. On this are arranged a series of receiving wheels in front of the shunt rail.

When the loaded bucket arrives the man operating the pier end runs the loaded bucket on the shunt rail until he comes to the place in the pocket where he dumps the coal, lifts up the latch, the bucket on a gudgeon, tips over, and returns, he then closes the latch, runs the now empty bucket round the radial end of the shunt rail, and gives it a good hard push, the wheels on the carrier run along the shunt rail until they come in contact with the rope (which has gone round the tension wheel) the clip then comes into operation, and the bucket is both suspended on the rope, and is carried along, passing the support towers, and arrives again at the loading station. I mentioned before that the wharf was situated 1,000 feet from the shore, and that the loading station is 200 feet further to the pit mouth and the screens: the time occupied by a loaded bucket leaving the loading station travelling out to the wharf, being unloaded, shoved round the shunt rail on the wharf, and returning to the end of the shoot to be reloaded is ten minutes.

The capacity of the system guaranteed by the makers, is 50 tons per hours, but this I am sure can be exceeded, but when we asked for estimates, that is the quantity we specified, and the makers advocate duplicating the plant, rather than make one to carry twice as much,

but this is a matter which can be arranged with the maker. We operate our system having a small boy to watch the engine, in case of any accident occurring, or an uneven distribution of the buckets (the rope having a tendency to race if the loaded rope gets too many loaded buckets placed on it in a short space).

One man at the loading station filling the buckets from the mouth of the screen, and one man on the wharf to unload the buckets, and run them round the shunt rail, and put them on the return rope, as already described, also to see that the wheels are kept greased and running all right.

We weigh the coal in the buckets by one of Fairbanks A scales, suspended on a section of the shunt rail.

The pier is designed as follows, viz. :—The first one hundred feet to contain four pockets of 90 tons capacity each, for loading schooners with a draft of water up to 14 feet at low tide, 200 feet now being built for the steamer section and having a storage capacity of 800 tons, there being from 18 to 20 feet of water at low tide along this section, plus four feet for high tide.

The tension on the ropes is with a capsan and thread bar, the tension weight being three tons, can be multiplied four times, giving a tension if required of 12 tons; but this we have not found necessary the ropes running most satifactorily, having considerable sag in the ropes between the towers.

On this coast we have heavy gales, and I anticipated considerable trouble, thinking that the buckets might swing on the ropes, and strike against the support towers, but in the heaviest gales last autumn, we ran the buckets both empty and loaded, and had no trouble whatever with them.

The whole system realizing our fullest expectations, and obliterating any idea that the shipping of coal by the aerial ropeway had any similitude of an experiment but demonstrating most successfully that it was a sure thing and just what we wanted.

Coal, Gas, and Coke as Domestic Fuels.

By F. H. Mason, F.C.S., Halifax, N.S.

The business man who consumes fuel for the purpose of raising steam, generally experiments carefully with the various kinds of fuel until he finds that which is best suited to the particular form of boilers he is using. The average householder, notwithstanding the fact that here in Canada he uses from 10 to 30 tons of fuel during the winter, generally buys his fuel without considering whether he is getting the best value for his money or whether the fuel he is buying is best suited to the particular form of furnace in which he proposes to burn it.

The writer in this paper proposes to deal with three kinds of fuel, namely, bituminous coal, and two products of its destructive distillation, coke and gas.

That fuel, whether it be coal, coke or gas, should be bought on its analysis, there is not in the writer's opinion even a shadow of a doubt, and further he thinks that the vendors should give a guarantee that the fuel is within reasonable limits of the analysis.

Bituminous coal, as we all know, is composed of carbon, hydrogen, sulphur, oxygen, nitrogen and ash, the last named being of varying composition and which, as we shall see later, plays a by no means unimportant part in the value of the coal.

The heat-giving properties of coal, we may say, for all intents and purposes, are obtained from the carbon, hydrogen and sulphur, and their respective calorific powers (taking the French unit of measurement, the caloric) are in round numbers 8,000, 34,000 and 2,200 respectively. The other ingredients may be looked upon as diluents, as may also the amount of hydrogen which is combined with oxygen in the form of water. In fact this latter is not only a diluent, but actually abstracts heat from the coal, such heat being used in converting the water into steam, so that in the case of coal approaching lignite where the percentage of water is considerable a very appreciable amount of heat is thus absorbed.

Besides the chemical properties of coal, the physical properties are of considerable importance. For domestic purposes those we have to consider most are, the toughness of the coal, the length of flame and the fusibility of the ash. From the toughness we learn the amount of slack with which we are likely to have to contend. The length of flame and the fusibility of the ash show us the adaptability of the coal to certain kinds of furnaces. Thus while a long-flame coal may be suitable for a furnace in which there is a good deal of stove-pipe area. it would be utterly unsuited for one which discharges its products of combustion directly into a brick chimney. Similarly with regard to the fusibility of the ash, a readily fusible ash will clinker on the fire-bar, and is also injurious to the lining of the furnace.

Coke, more than any other form of fuel, should be sold on its analysis, for two reasons; 1st, owing to its highly porous nature, it will hold a very considerable percentage of water without having even the appearance of being moist. When coke is delivered to the purchaser in such a condition that it feels damp and soils the hands. it is fairly certain that it contains in the neighborhood of 20 per cent. of water, and as has already been stated with regard to coal, not only is the water a diluent, but that it will actually render latent the heat value of a further percentage of the coke in converting the water into steam.

When coke is taken from the retorts or ovens it is quenched with water, and there is a very considerable art in adding just the required amount. Such a quantity of water is required as will thoroughly quench the exterior of the coke, while at the same time leaving sufficient heat in the interior to drive off the excess of water.

The writer has known coke to have been delivered to the consumer containing 29 per cent. of water, and that on a hot summer day when there was no possible excuse that it might have been caused by rain.

2nd. In the destructive distillation of coal from 60 to 70 per cent. is converted into coke, and this coke contains all the ash of the original coal, so that a coal with a high ash will give a coke with a very much higher ash, and not only is this ash incombustible matter, but it is

taking up a considerable amount of furnace space with inert material, and entails an extra amount of labor in its removal.

Two kinds of coke have to be considered, namely, retort coke and oven coke. The former may be said to be a bye product in the manufacture of gas. In the case of the latter gas is a bye product in the manufacture of the coke.

A good oven coke when supplied to the customer should not contain more than 3 to 4 per cent. of water and volatile matter combined; it is denser than retort coke, more difficult to light and gives a more intense local heat.

The volatile matter in retort coke varies considerably. In cases where both a lighting and fuel gas is supplied, the amount of gas left in the coke is less than when only lighting gas is made, for the reason that in the destructive distiilation of coal, a gas much poorer in lighting properties comes off at the early and final stages of distillation than at the middle stage, so that when only a lighting gas is required the distillation is stopped before the whole of the gas has been evolved.

In gas we have a more uncertain quantity to deal with; its composition is very variable. The same coal distilled under different conditions of temperature and pressure will give a gas of a different composition.

Gas may be said to be composed mainly of:

	Calorics.
Hydrogen, having a calorific power of.....	34,500
Hydro carbons of the marsh gas series having a calorific power of.....	13,050
Hydro-carbons of the olefiant gas series having a calorific power of.....	4,850
Carbon monoxide, having a calorific power of.....	2,400
Oxygen and nitrogen (diluents).	

These calorics are the number of grammes of water one gramme of the substance will on complete combustion raise from 0° to 1° centigrade. But as we buy our gas by the cubic foot and not by the pound, it is necessary to convert these into calorific powers by volume and this may be done by multiplying the calorific power by the density of the gas. Taking the density of hydrogen as one we shall obtain the following figures:—

Hydrogen 34,500
Marsh gas 104,400
Olefiant gas.....153,050
Carbon monoxide. 31,600

It will be noticed the olefiant gas gives the highest calorific power by volume, and as it is this series of gases which gives the luminosity to the coal gas flame, it therefore follows that the higher the luminosity of a gas, the greater the calorific power.

A ton of good bituminous coal at say $4.00 is capable of producing from ten to eleven thousand cubic feet of gas at say $1.00 per 1,000 feet, and from six-tenths to seven-tenths of a ton of coke at say $3.50 per ton, so that where a continuous fire is required gas cannot seriously be considered as an economic fuel at its present price in Canada. For warming rooms, however, where fires are only required for short intervals, it has many advantages from the fact that there are no ashes to remove, it is an exceedingly clean fire, and it can be lighted at any moment and be extinguished equally quickly.

The average burner for gas fires sadly needs reconstruction, as in matter of fact do the whole arrangements of the fire. Little or no work has been done in the direction of improving gas fires and the old method of heating up a number of irregular shaped masses of a mixture of fire-clay and asbestos is still in vogue and no very great improvement has been made during the last 20 years. With regard to the burner it is essential, to get the best results, that the consumer should be capable of regulating the supply of air to be mixed with the gas previous to combustion.

A tremendous amount of work has been done in the way of experimenting on burners for the purpose of incandescent gas lighting, and it has been found that the best results are obtained where not only is the air capable of being regulated, but when it is admitted at different stages in the burner, thereby insuring its more complete mixture with the gas prior to combustion.

Probably the most perfect burner is that invented by Bandsept, which consists of a series of short truncated cones, each having a wider opening than the one immediately below it. Air is admitted at

the base of each of these cones, and is drawn in by the flow of gas in the case of the first cone and air and gas in subsequent ones. Finally the air and gas go into an inverted truncated cone, to allow them to become expanded by the heated burner top; it then passes through two layers of gauze wire, where the mixing is completed, and is burned on the top.

Professor Vivian B. Lewis has carried out some elaborate experiments with a view of determining the amount of air required to be mixed with coal gas prior to combustion, to obtain the highest temperature air and gas were supplied to a burner after passing through standard meters, the gas supply being kept constant at 5 cubic feet per hour under a pressure of 1.5 inches of water. The supply of air was varied and the temperatures taken with a Le Chatelier thermo pile.

Working with London gas having the following composition:

Hydrogen.....	60.4	per cent.
Marsh gas.....	28.1	"
Olefiant gas.....	4.0	"
Carbon monoxide..	5.0	"
Oxygen.....	0.5	"
Nitrogen.....	2.0	"

he found that the maximum temperature was obtained in the outer zone of the flame when the ratio of air to gas was as 2.75 is to 1, and that increased aeration lowered the temperature less rapidly than decreased aeration. By exploding this gas he found that it required 5.5 times its volume of air to complete its combustion. It will be noticed that the correct aeration prior to combustion was exactly half the amount of air required for its complete combustion.

A Bunsen burner to be working at its best advantage should show an absolutely non-luminous flame with a well-defined inner zone of a greenish tinge. Gas fires, where the products of combustion discharge into the room undoubtedly give the best heating results, but they are far from hygienic and for that reason alone are not worthy of further consideration.

The next best results are obtained from gas stoves where the products of combustion are conveyed through a metal pipe to a chimney.

The gas fire burning in an open grate certainly wastes a good deal of heat up the chimney, but if set low and brought well forward towards the front of the grate the amount of waste can be considerably reduced.

With regard to a material to absorb the heat locally and throw it into the room the usual irregular shaped masses of fire-clay, or fire-clay and asbestos, leave much to be desired. As a gas fire is essentially a fire to be used occasionally, it is necessary that it should reach its maximum heating power rapidly. In this respect these irregular masses of fire clay and asbestos leave much to be desired. The writer has been experimenting in this direction and up to the present has obtained the best results by loosely winding balls of cotton wick and soaking them in a saturated solution of mixed nitrates of aluminium and chromium, the salts being mixed in the proportion of 10 per cent. nitrate of chromium and 90 per cent. nitrate of aluminium. The balls are allowed to dry and then placed in the grate, and the fire lighted; the heat burns off the carbonaceous matter and converts the nitrates into oxides. The back of the grate is fire-clay, the surface of which is rendered spongy by mixing the clay with cork dust; when the clay is fired the cork dust burns out, leaving a spongy surface. The principal disadvantage to this arrangement is that the balls and spongy fire-brick are very fragile and will not admit of much handling, and it is out of the question to use this arrangement if the fire is required for boiling a kettle or any purpose other than heating the room.

The writer is of opinion, however, that there is considerable room for experiment in this direction, and that if a satisfactory open gas fire were devised, it would be much more frequently used for rooms where a fire is only required occasionally.

Having reviewed the principal points of the three fuels under consideration, and gone rather more fully into gas as it is not proposed to deal further with it, it is necessary to draw comparison between them when used for domestic heating.

Pound for pound, provided combustion is complete, an average

bituminous coal is capable of giving an average coke some 500 calorics. But in almost all furnaces and stoves used for domestic heating, the combustion of coal is far less complete than that of coke.

Undoubtedly a considerable proportion of the volatile matter in coal escapes combustion. Especially is this the case when fires are banked to keep them in over night.

For furnace purposes, whether for heatiug by hot air, hot water or steam, where an intense local heat is required, to heat water or an air chamber as the case may be, in the writer's opinion coke will compare favorably both in economy and effectiveness with any other form of fuel.

The writer has obtained the greatest satisfaction with coke made from both Cape Breton and Pictou coals in a hot air furnace.

In the case of Cape Breton coke, the ash of which is largely composed of sulphide of iron, the best results were obtained in a furnace with no fire bars, and a fire-brick bottom; the ash, as it descends towards the lower part of the furnace, fuses and forms a solid cake at the bottom, from which it is readily detached and removed, thus causing a very considerable diminuation of dust and dirt, and occupying very little space, compared with the ash of anthracite coal. The ash of the Pictou coke is largely clay slate, and by no means readily fusible and fire bars are necessary.

A coke furnace should have a somewhat larger capacity than an anthracite coal furnace for the reason that it does not pack anything like so tightly owing to its granular form.

Open grates of course are anything but an economic method of heating, but as they are a luxury which the average individual demands, and on account of their ventilating properties are highly hygienic, it is well to consider the best fuel for them. The writer has found that a good free burning coal, such as the coals of Cumberland County or Inverness County, to give the greatest satisfaction.

Coking coals, especially strongly coking coals, require considerable attention to keep a really hot fire, and where a free burning coal is not easily obtainable a mixture of coking coal and coke will give better satisfaction than coking coal alone.

One word in conclusion in condemnation of large stove-pipe areas in living houses. That tired feeling (as the patent medicine advertisement runs) in the morning is, in the writer's opinion, often due to the large amount of carbonic acid gas in the house. Graham's law of the diffusion of gases, namely, that the relative rates of diffusion of gases are inversely proportionate to the square root of their densities has to be considered with stove-pipes, notwithstanding that the induced current inside the pipe is striving to overcome it. That it does not overcome it can be practically demonstrated by inserting a few small pipes with badly-fitting joints, similar to a stove-pipe, inside a glass tube, and filling the space between the pipe and the glass tube with hydrochloric acid gas, then aspirate ammonia gas through the inside pipe; at the joints of the pipe inside the glass tube the white fumes of ammonium chloride will be seen, clearly showing that ammonia gas has diffused from the inner pipe to the outer tube, notwithstanding the fact that there was a suction in the inner pipe. The same thing occurs with the ordinary stove-pipe in a house, and when the house is shut up during the night sufficient carbonic acid escapes into it to cause heaviness and headache to the occupants.

The Treatment of Auriferous Mispickel Ores at Deloro, Ontario.

By Sidney B. Wright, F.I.C., Deloro, Ont.

Before proceeding with particulars as to the actual treatment of the concentrates mentioned by Mr. Kirkegaard, a few words on the chemistry of the process adopted will the writer thinks, be in order although already fully gone into by Messrs. Sulman and Teed in papers communicated to the Society of Chemical Industry.

Briefly the process consists in :

(1). The "Extraction" of the Gold by the leaching of the finely ground ore with a dilute solution of Potassium Cyanide, to which is added a small quantity of a solution of a "haloid" salt of Cyanogen—Cyanogen Bromide.

(2). The "Precipitation" of the precious metal from this Bromo-Cyanide "liquor" by means of metallic Zinc.

(3). The "Clean-up" of the Zinc-Gold Slimes thus obtained.

In comparing the equation representing the solution of metallic Gold by the Bromo-Cyanide solution, viz: $3\ K\ Cy + Au_2 + Cy\ Br = 2\ (K\ Au\ Cy_2) + K\ Br$, with Elsner's well-known equation for the solution by Potassium Cyanide, $4\ K\ Cy + Au_2 + H_2\ O + O = 2\ (K\ Au\ Cy_2) + 2\ K\ O\ H$, it will be readily seen that whereas in the former case the reaction is one of "Cyanidation" only, the latter, as is now generally admitted, involves oxidation, a reaction, the disadvantages of which in the treatment of ores rich in Sulphur, Arsenic, etc., are apparent.

On this point and on the extreme activity of the Bromo-Cyanide solvent on the precious metals together with the method of application of the process, depends largely the successful treatment of these dense concentrates.

Plant.—The plant now in use, and which is placed in a two-story building below the Mill, consists of :—

Four Leaching Vats fitted with sand and pebble filter bottoms, and bottom discharge-gates.

Four Solution or "Liquor" tanks—on the floor above the leaching vats.

Three small Northey Duplex Steam Pumps for pumping liquors.

Three small "sump tanks," 40 gallon barrels, over which the steam pumps are so placed that by means of a float connected by a rod to a lever on a special type of throttle-valve the speed of the pumps is regulated automatically by the rise and fall in level of the liquors flowing into the sumps. Two 50 gallon barrels holding the Stock Solution of Cyanogen Bromide.

Precipitation.—*One* Sulman's patent "Cone" for the use of Zinc Fume or "Dust" as the precipitant.

One Settling-box connected with same.

One Zinc box through which all drainings only from the vat charges are run.

Pipe Systems.—The pipe systems employed are so arranged that the liquor from each tank may be run to any leaching vat independently; similarly the systems fitted to the bottoms of the leaching vats run to the small sumps from which the liquors having percolated through the charge of ore, may be pumped to any of the liquor tanks desired.

In this connection it may be mentioned that each pipe-line run is painted with a different colour in order to obviate any chance of a mistake being made in opening or closing the cocks, for any particular run. Asbestos-packed cocks are used in all these pipe systems and have proved a great advance on the old iron "plug" cock for this work.

Clean-up.—The clean-up plant in which the Zinc-Gold Slimes, obtained in the precipitation of the Gold from the liquors by means of metallic Zinc, are treated, consists of:—

One "Acid-Treatment" Tank fitted with a hood and stack by which the obnoxious gases evolved during the acid-treatment are carried immediately out of the building. A small steam jet is used in the stack in order to ensure a good draught.

One Settling-Tank, and *One* Filter-Tub into which the Slimes are run after acid-treatment and washing.

This, briefly comprises the whole of the plant used in the "Extraction" building and since the final smelting of the "Slimes" is carried out in the Bullion-Room attached to the Laboratory, the furnaces employed there will be described further on.

The actual treatment of the Vat charges may now be taken.

Treatment.—The wet concentrates, as received from the Mill, consist principally of Mispickel, some Iron Pyrites carrying small but varying quantities of Copper, and 15 per cent. to 20 per cent. of Quartz-sands The latter is taken over purposely on the Concentrators and plays an important part in rendering these dense concentrates leachable. In this connection it may be mentioned that experiments were made by the writer on the separate treatment of *three* grades of the "sized" concentrates but the results obtained were inferior to those which the mixed products gave.

The wet mass of concentrates, mixed to some extent in the concentrator room and transferred in side-dumping cars to the leaching vats, is therefore dumped direct into the latter and a small quantity of Caustic-Lime added.

Here a further slight mixing is given by shovelling and spreading occasionally until the vat contains a charge about three feet deep, or approximately 40 tons of concentrates.

The surface is now levelled off and the charge sampled.

The sample obtained by the usual method, viz., that of withdrawing a small quantity from each car-load by means of a pipe was soon found to be unreliable and was therefore abandoned The method now adopted consists in taking drillings by means of a 2 inch auger—3 feet long—the entire depth of the vat charge.

The pulp thus obtained from twenty to thirty drill-holes is then well mixed, quartered down in the usual way, and is found to constitute a very accurate sample.

The charge is now submitted to a short Water Wash in order to get rid of the soluble "cyanicides" formed by the exposure of the moist

concentrates to the action of the air during the filling of the vats, and this is the only preliminary treatment given.

After partial draining, or as soon as the water has disappeared below the surface of the ore, the cyanide solution or "liquor" is run on together with the requisite quantity of Cyanogen Bromide Solution. The original quantity of solution or "liquor," which for convenience may be called the "Strong" liquor, run on is, in all, approximately one third of the weight of the ore-charge—or thirteen tons. Formerly a Weak Cyanide Solution was run on previous to the above-mentioned liquor with the idea of reducing cyanide consumption. This weak liquor, however, was found to exert practically no influence in the latter respect and at the same time dissolved only a very small quantity of Gold. It was therefore abandoned and the length of treatment materially reduced in consequence.

The first mentioned liquor having been run on to the charge the water remaining from the preliminary wash, and now being replaced by the Bromo-Cyanide Solution, is run out through the Zinc boxes.

At this stage a somewhat radical departure from ordinary practice is made, and one which has proved a necessity in treating this refractory material.

It being the fact as in nearly all leaching operations that the first portion of the liquor to pass through the ore charge is extremely rich, comparatively, in the dissolved metal, a rapid and easy means of ascertaining the correct point at which to "switch" to the liquor tanks becomes necessary.

The usual "Silver Nitrate" test, though applicable in the treatment of most ores was found unsatisfactory in this case even in skilled hands, and since it frequently happens that such tests must be made by the workman in charge of the vats it will be readily understood that a simple and decisive test is an absolute necessity. It was found on examination that the very dilute solution first appearing through the charge, although extremely weak in free K Cy, contained an appreciable quantity of soluble "Ferrocyanides."

Advantage was therefore taken of this fact to apply the delicate "Prussian Blue" test, by adding "Ferric Chloride" solution to running

samples drawn from the Zinc boxes. By this means on the first appearance of Gold-bearing solution a distinct Prussian Blue coloration is obtained and the operator knows at once when to switch to the liquor tanks.

The departure from ordinary practice mentioned above now takes place.

It consists in switching this very dilute (in K Cy) solution *not* to the *Weak* but to the *Strong* tank and as a further distinguishing point between Bromo-Cyanide treatment generally and ordinary Cyanide practice it may here be mentioned that this "Strong" liquor may be used, without any precipitation of the Gold by Zinc or other means, until it contains as much as 6 to 7 ozs. of Gold per ton of liquor if desired.

This practice although considered unsafe in many cases in ordinary cyanide work is perfectly free from danger in the Bromo-Cyanide treatment of this ore.

In the latter case it is also advantageous to precipitate the "Strong" liquor as seldom as possible, within the above-mentioned limits on account of the fact that by contact with metallic Zinc the Cyanogen Bromide is decomposed and the liquor thus rendered much ess a ctive.

To revert to the actual treatment of the charge—the "blue" coloration having been obtained and all the liquor having been run on, the solution now percolating through the charge is run to the "Strong" tank and is brought up to correct strength by the addition of the requisite quantity of K Cy.

Constant slow percolation of the liquor through the ore is found to render the solution of the Gold much more rapid than if soaking and percolation be adopted and for this reason the liquor is run back to the Strong tank, as stated previously, and is run on to the charge at intervals with the requisite quantity of Cy Br solution.

After twenty four hours' leaching it is found that 60 per cent. to 70 per cent. of the gold contents have been extracted and at this point it is advantageous to drain the charge, and turn the mass by shoveling in order to break up and mix any clots of fine mispickel which may be

present, and thus expose fresh surfaces to the action of the Bromo-Cyanide liquor. The latter is now again run on and the leaching continued until assays of samples of the liquor show that the extraction is completed.

A weak "Wash" liquor is now run on to replace the "Strong" solution, the latter being run off at full bore of the pipe. As soon as the original 13 tons of Strong liquor have been collected the stream is switched to the "Weak" tank and a water wash run on to the ore.

The original quantity of "Weak" liquor used is collected and this collection is continued until a running sample of the washings shows on testing that the stream may be run out through the Zinc boxes. In this way it will be noticed, the quantity of Strong liquor in use is retained at the original 13 tons, while the Weak or Wash liquor is allowed to increase in bulk with each leach.

By this method the Strong liquor is refreshed with clean solution in each charge treated, and on the great activity of the Bromo-Cyanide solvent in conjunction with this retaining of the working solution in a clean condition depends largely, in the writer's opinion, the successful treatment of these concentrates.

The Weak Wash liquor, accumulated as above-mentioned, is used to wash several charges and is always precipitated ahead of the Strong solution so that when the latter is rich the former is practically free from Gold.

Precipitation of the Gold.—For this purpose Zinc Fume or "Dust" a bye-product obtained during the operation of Zinc smelting, is employed.

The Plant consists of an inverted cone of sheet-iron 4 feet 6 inches in diameter and of the same depth. This is fitted at its apex with a three-way cock and a small perforated cone or *rose*, which serves to distribute the stream uniformly, thus ensuring thorough admixture of the liquor with the Zinc Fume which is run in at intervals through a central funnel and pipe.

The latter is expanded at its lower end into an inverted funnel and by deflecting the stream of liquor helps to mix the "fume" and liquor still more thoroughly.

The liquor to be precipitated is run from the storage tanks into a 40 gallon barrel the delivery into which is fitted with a ball-cock in order to obviate any chance of overflow.

This barrel is connected with the three-way at the apex of the cone by a pipe and, being placed above the top rim of cone, serves to maintain a constant head. The liquor thus runs direct into the bottom of the cone and meets the Zinc fume just above the distributing rose. In the upward travel, however, of the solution the Zinc and Zinc-Gold particles descend again into the precipitation "Zone" by reason of the decrease in velocity of the currents with the increasing area; thus a *small* quantity of the "Fume" exposing, in proportion, an enormous surface of metallic Zinc to contact with the liquors serves to precipitate the Gold from a large quantity of liquor.

The precipitated liquor which, by the time it reaches the rim of the cone carries only a small quantity of suspended matter, now overflows into a peripheral gutter and thence to a wooden settling-box containing two compartments in which a number of glass plates 24 in. x 18 in. are placed at an angle of 45°.

Thence the perfectly clear liquor flows to the sumps and is again ready for use on the ore charge.

It may here be mentioned that the "settling-box" will shortly be replaced by a small filter-press or other convenient form of filter which will be used firstly, as a means of separating the small quantity of suspended slimes from the flowing liquors and secondly as a receptacle for the slimes withdrawn from the bottom of the "cone" when the precipitation "run" is completed.

The advantages obtained by adopting Zinc Fume as the precipitant, as compared with the older Zinc "Shavings," method are briefly :—

(*a*). A closer and more uniform precipitation of the precious metal from the solutions, 99 per cent. of the original contents being the regular proportion thus obtained.

(*b*). The production of rich Zinc-Gold Slimes.

(*c*). Ease and rapidity of manipulation in clean-up.

(*d*). The rapid conversion of all the Gold extracted by the liquors into marketable bullion.

(*e*). The low cost for Zinc consumption.

Clean-up.—The Gold bearing precipitate, whether obtained from the Zinc-boxes or from the "Fume" cone is now treated with Sulphuric Acid in order to get rid of the Zinc present. This is carried out in a room adjacent to the Extraction building, all the precipitate collected during the month being treated in one lot in the Acid tank.

The strength of Acid used is approximately one part in four parts of water.

The moist precipitate is placed in the Acid tank the requisite quantity of water added, the hood which is fitted with a small glass window front and back so that the action may be observed, closed down and the Acid run in through a leaden funnel.

The mass is stirred with a wooden paddle, the handle of which projects through a small opening in the front of the hood, and as soon as the first violent evolution of gas has subsided somewhat, more acid is run in. The stirring and additions of acid are continued until the reaction is seen to be complete. The tank is now filled with *cold* water, stirred well and allowed to settle. By using *cold* rather than *hot* water a more rapid settling of the Gold slimes is effected and after two further decantation washings the slimes are obtained free from Zinc Sulphate. All the washings from this are run into the Settling *tank* in which they are allowed to stand until thoroughly settled; the clear solution, which on assay shows only traces of Gold, is then run off and the small quantity of fine precipitate on the bottom of the tank collected.

The Gold-slimes in the acid tank are rinsed into the filter-tub as soon as the third "wash" has been run off and, after draining, are transferred to shallow sheet-iron trays. These are placed in a special form of oven-furnace in which the contents are first dried and finally heated to a dull red heat.

The furnace itself consists of a small wind-furnace, which is used for the melting of bullion and which is fitted with a hinged damper so that when required the trays containing precipitate may be heated by the *waste* heat from the furnace. This is effected by placing the trays on shelves in the oven one above another in such a way that the spaces

between them form the flue through which the furnace gases pass to the stack.

By this means the objectionable vapours evolved during the roasting of the slimes are carried away and at the same time no loss by dusting is experienced on account of the large flue area allowed between the trays.

The roasted slimes are now mixed with a suitable flux, smelted in *clay* crucibles which for safety are placed inside graphite pots, and the smelt finally cast in the usual "brick" moulds.

The Slags obtained which are exceptionally clean are allowed to accumulate and are treated at intervals by Caldecott's process.

Although this paper has been confined to the treatment of one particular class of material it may also be mentioned that the writer has had opportunities for making comparative tests of the merits of the Bromo-Cyanide as compared with the ordinary Cyanide process in treating ores and tailings of various descriptions, and has found that with practically all the so-called "refractory" ores treated the best results both as regards cost and extraction have been obtained by using the Bromo-Cyanide process, the difference being sufficient in many cases to convert an uneconomical treatment into a profitable operation.

The following figures representing the chemical consumptions and extraction on the concentrates, in conjunction with the saving effected by amalgamation, speak for themselves :—

Potass. Cyanide per ton of concentrates treated....	2.0 lb.
Cyanogen Bromide per ton of concentrates treated.	0.5 lb.
Zinc Fume per ton of concentrates treated.....	0.19 lb.
Total length of treatment....	80 to 100 hours.
Extraction of Gold from Concentrates	87 per cent. to 94 per cent.
An average of.....	90.5 per cent.

This latter with the values saved by amalgamation gives a *total* saving of 88 per cent. to 90 per cent. of the original Gold contents of the Milling Ore a result which, as an average of two years' steady work, will it is thought be generally admitted to be exceptional on so refractory an ore.

The Composition of some Canadian Limestones.

(A) For Calcium Carbide. (B) For Chemical Wood Pulp. (C) For Portland Cement.

By J. T. Donald, M.A., Montreal.

The rapid development of industries in which lime or limestone is a raw material has given a new interest to this common mineral.

The term limestone, however, as generally used includes any rock in which carbonate of lime is the predominant ingredient.

This of course gives a wide range of composition.

The ideal limestone is pure calcium carbonate containing 56 p.c. of lime and 44 p.c. of carbon dioxide.

The conditions under which beds of limestone have been deposited were such that it is scarcely possible to find them fully up to our ideal in degree of purity.

Being a sedimentary rock, we usually find limestone containing more or less siliceous matter, either as silica or as silicates.

The amount of siliceous matter may vary from a few tenths of one per cent. up to even forty or fifty per cent.; in which latter case it is a question whether we should consider we have a sandy limestone or a calcareous sandstone.

But again, in nature we usually find that carbonate of lime is associated with carbonate of magnesia; indeed, it is scarcely possible to find a limestone that does not contain an appreciable percentage of magnesia; whilst on the other hand the magnesia may occur in such percentage that the stone becomes a magnesian limestone or dolomite, which normally contains: Lime 30.40 p.c., Magnesia 21.70 p.c., Carbon dioxide 47.90 p.c.

In addition to silica or silicates, and magnesia, all limestones contain more or less of what someone has aptly called the "intruder into everything on earth" viz., iron, in the form of iron oxide or iron sulphide.

The principal industries that call for limestone as one of their raw materials, are:

Calcium Carbide.
Chemical Wood Pulp.
Portland Cement.

The object of this brief paper is to state in a general way the characters of the limestone required in each of these industries, illustrating by reference to Canadian limestones that have been analysed by the writer.

(A) *Calcium Carbide.*

A limestone to be suitable for the manufacture of this article should be as nearly as possible pure calcium carbonate. The presence of magnesia is particularly detrimental. A small percentage of siliceous matter and a little iron oxide may be tolerated. These points are illustrated by the following analyses.

I.—Is being used in a Canadian carbide works.

II. and III.—Are unsuitable for carbide; II. because of the magnesia it contains; and III. on account of the high percentage of siliceous matter.

	I.	II.	III.
Insoluble	——	2.14	10.92
Carbonate of Lime	96.89	52.00	87.71
Carbonate of Magnesia	1.64	42.71	.30
Iron Oxide	——	2.20	.70

(B) *Chemical Wood Pulp.*

For soda pulp, *i.e.* pulp made by "cooking" the spruce or other wood in a solution of caustic soda, any ordinary good limestone will yield a lime suitable for causticising the soda.

But in the case of sulphite pulp it is otherwise; selected material is required. In this case the presence of magnesia is desirable, indeed the higher the percentage of magnesia, the more desirable is the stone. But iron is decidedly objectionable; its presence causes discoloration of the pulp. The following analyses are of Canadian limestones.

I. is an excellent stone for sulphite pulp. II. whilst good in other respects contains too much iron. III. does not contain sufficient magnesia.

	I.	II.	III.
Insoluble	2.10	2.14	.14
Carbonate of Lime	56.21	52.00	98.78
Carbonate of Magnesia	41.20	42.71	Traces.
Iron Oxide	.09	2.20	.19

(C) *Portland Cement.*

This article is made by calcining a mixture containing proper proportions of silica, lime and alumina; this is usually a mixture of limestone and clay. A somewhat wide range of material is admissible in this industry. Magnesia is debarred to the extent that the finished cement must contain less than 3 per cent. of magnesia.

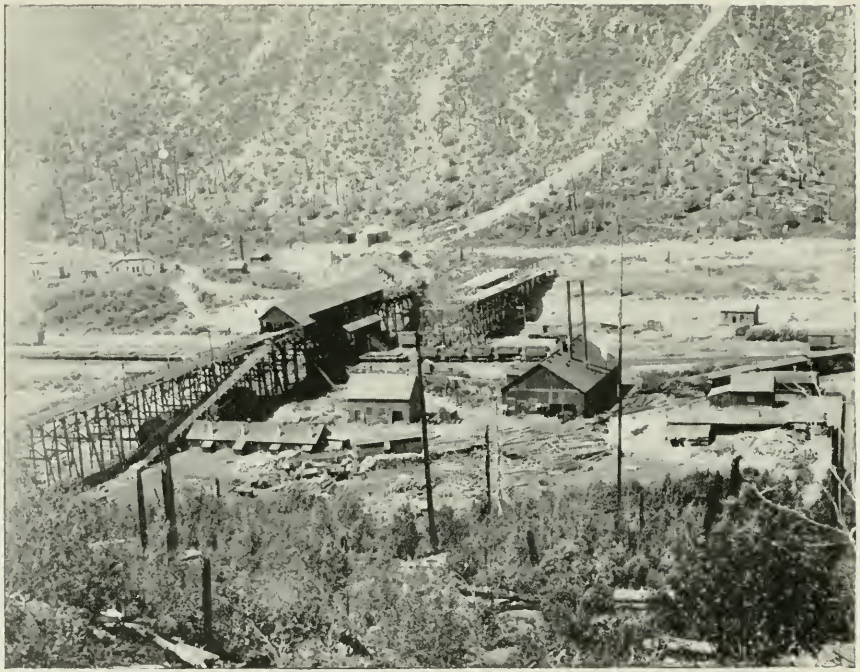
A limestone comparatively high in silica is admissible here, provided a clay or shale rich in alumina is obtainable.

A certain kind of impure limestone is the sole raw material for certain kinds of Portland cement. This is commonly known as natural cement rock. It is really an argillaceous or shaley or clayey limestone; that is, it is the materials for Portland cement ready mixed by nature.

The following analyses illustrate the statements just made.

I. is an ordinary limestone suitable for cement. II. contains too much magnesia. III. is a natural cement rock.

	I.	II.	III.
Insoluble	1.51	20.23	24.74
Carbonate of Lime	97.21	50.37	41.80
Carbonate of Magnesia	1.15	24.63	8.60
Iron Oxide	.17	2.81	6.30



Coal Creek Colliery—View Surface Works looking North towards No. I Colliery.

The Coal Creek Colliery of the Crow's Nest Pass Coal Co.

By C. V. Corless, McGill University, Montreal.

The coal-fields of the Crow's Nest Pass Coal Company lie just beyond the Crow's Nest Pass over the continental divide at a distance of about forty miles from the international boundary. They front on the Elk River, being situated in the most south-easterly mining division of British Columbia, that of Fort Steele.

The mines of the Coal Creek Colliery are situated in Coal Creek Valley, five miles east of Fernie, a town at the confluence of this stream with the Elk River. They are at an altitude of 3,800 feet above sea-level and 525 feet above the town-site of Fernie.

The measures have the usual rolling character of all Rocky Mountain coal seams. Their general line of strike is approximately north and south. Their dip varies from level to about 20 or 25 degrees, the rise being toward the west. The outcrops are, therefore, along the mountain sides to the west, at varying heights.

The mines, Nos. 1 and 2, are situated respectively on the north and south sides of the valley, about 1,000 feet apart. Though relatively on the same level, the mines are not opening up the same seams, as shown in the accompanying geological section.

Old No. 1 Tunnel, on the north side of the valley opened up the lower six-foot seam shown in the sketch, but this seam has been abandoned for the present, the tunnel being used as a return air-course for No. 1 Mine. The new No. 1 Tunnel is working an eight-foot seam of excellent quality. This seam is the top section of the thirty-foot seam, shown in the geological section, and is situated about fifty feet above the original six-foot seam.

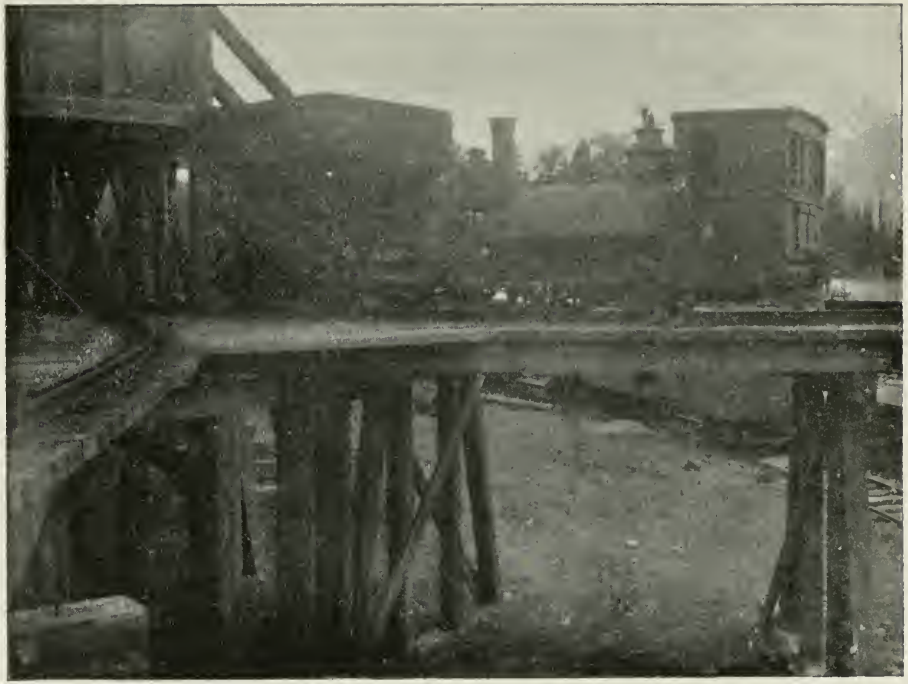
No. 2 Tunnel, on the south side of the valley, has opened up the upper portion of the eleven-foot seam shown in the section. The upper six feet is being extracted. The under five feet, constituting the pavement, is alternating bands of coal and shale. This forms, general-

ly, a splendid floor. The roof of this mine is of great strength and regularity.

Geology.—These coal measures occur in the Laramie Formation of the Upper Cretaceous series of rocks. In this district this formation comprises some thousands of feet of alternating bands of conglomerate and sandstone, the single strata varying from a few inches to hundreds of feet in thickness. At frequent intervals in these strata, but always immediately beneath a layer of sandstone, occur the coal seams with their accompanying carbonaceous shales. The enclosed geological section for which the measurements were made by the writer, while engaged at this colliery during the summer of 1900, shows the arrangement and thickness of the near lying strata at the Coal Creek Colliery. It would appear that the strata of conglomerate were laid down along an ancient sea-beach that oscillated back and forth owing to the repeated, alternate elevations and depressions of the Laramie Sea-bottom, the coal-beds marking long periods of small emergence and persistent marshes in the alternating changes of level. The Valley is glacial.

"The cretaceous," says Dana, "was the coal period of western America." To what extent this district was favored during the period of coal making, may be gathered from the following quotation from the December number of *The Colliery Guardian*, 1900 :—

"In Crow's Nest Pass there are twenty seams of bituminous coal, three of which are 15, 20 and 30 feet thick respectively. The aggregate thickness of the seams reaches the large total of 132 feet of coal, and the area of the field is 144 square miles. This area is estimated to yield 50,000,000 tons of coal per mile and promises to be one of the most productive coal-fields of Canada." This estimate is very conservative, as the area is officially reported to be 250,000 acres or about 400 square miles, with seams aggregating 150 feet in thickness. The estimates of some engineers place the quantity of coal within this area at 25 billions of tons, which would admit of an output of 25 million tons a year, or 70,000 tons a day, for 1,000 years. Doubtless, the use of the diamond drill in the valleys, would reveal many as yet undiscovered seams. The coal in the seams exposed up to the present, is very uniform and of excellent quality. It is said to be the best coking



Coal Creek Colliery—The Lorry.

coal in America, the coke possessing high calorific power and great crushing strength, two most important qualities demanded of coke that is to be used for smelting.

The coal mines of the Crow's Nest are well situated for furnishing coke to smelters. But smelting is only in its infancy in southern British Columbia, there being at present 5 establishments, one at Nelson, one at Trail, one at Pilot Bay and two others in the Boundary Country.

Situated as it is, with vast metalliferous deposits to the south, west and north, the importance of this inexhaustible supply of smelting fuel, in the development of the "Great West," can hardly be overestimated.

The relative positions of Nos. 1 and 2 Mines, and of each to the surface plant, will be made clear by referring to Photo No. 1 and to the accompanying plan of the mines. In order to concentrate the surface labor and shipping plant the mine tunnels are connected by a trestle forty-five feet high above Coal Creek. The Weighing and Sorting Building is placed upon the trestle equidistant from the mine entrances. This building contains the scales, Mitchell tippler for dumping the mine-boxes, shaker screens, travelling picking-table, engine for the screens and picking-table, and loading arrangements to facilitate shipment in railway cars (See Photo No. 2).

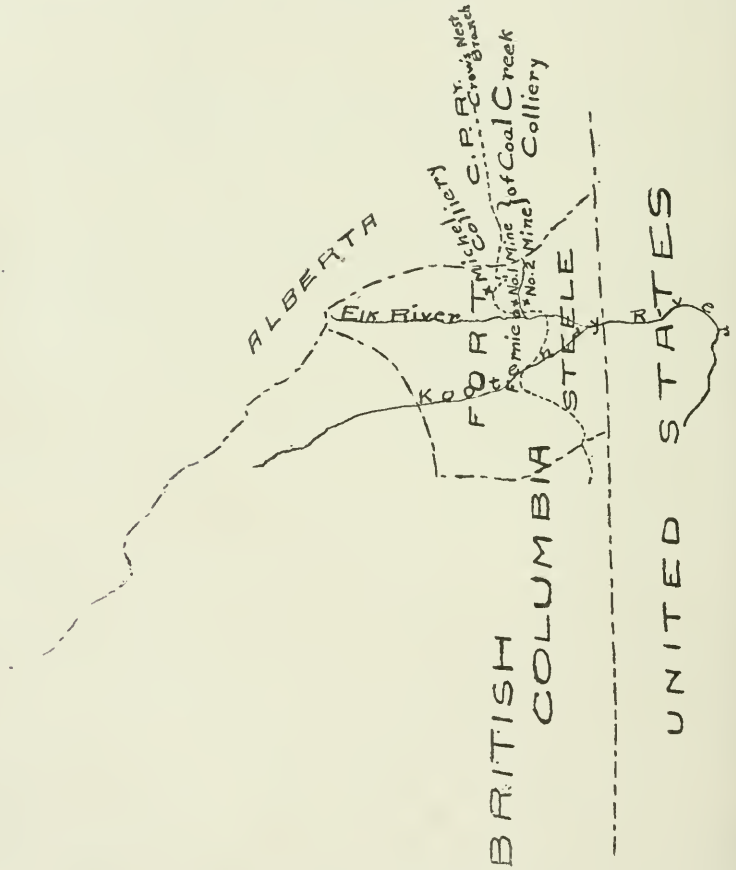
In both mines the coal is being extracted on the "pillar and stall" system, the seams being too thick to be successfully worked by "long-wall." The main levels and headings are driven 12 to 14 feet wide and the rooms or stalls, about 18 feet wide. The stalls are driven parallel as far as the undulations of the strata will permit and are connected by cross cuts at intervals of 50 or 60 feet. This is done in order to short-circuit the air and dispense with the temporary brattice.

As will be seen from the plan, owing to difficulties in haulage arising from undulations of the mountain strata, the pillars are somewhat irregular both in size and position. They are, in general, about 45 feet square and are being increased in size as the workings extend north and south into the mountains which rise precipitously above the mines to the height of about 2,000 feet. This increase in size is in

order to prevent a crush of the pillars or a creep in the overlying strata resulting from the enormous superincumbent pressure. It is not probable that any of the pillars will be robbed until all easily accessible, overlying seams have been extracted.

In order to stop a creep, should one occur, it may become neces-

PLATE I.

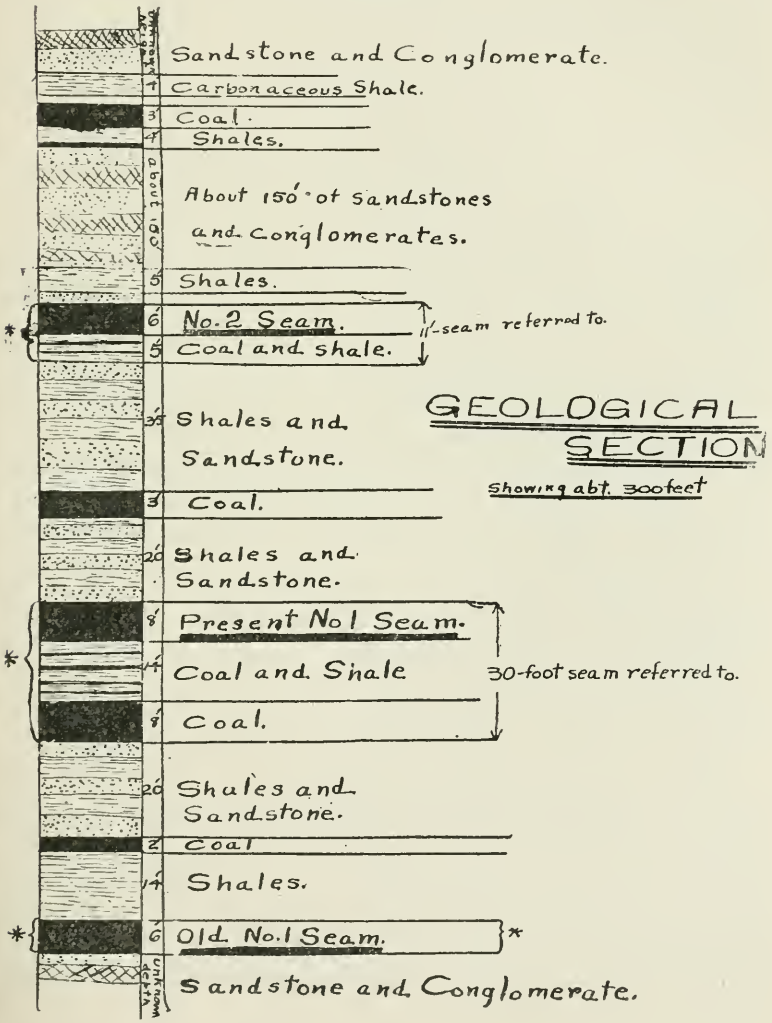


sary to rob a section of five or six hundred feet square and allow the roof to settle.

Though two electrically driven coal-cutting machines were pur-

chased, they were in use only a short time owing to the excessive dip and rise in some parts of the mines. At present all cutting is done by hand. Much of the coal can be easily brought down by means of the pick alone, after the usual under-cut has been made. In gassy rooms

PLATE II.



the maul and wedge are used to bring down the coal when digging is difficult. But in rooms in which naked lights are used, after the under-cut has been made, the coal is blasted down by means of No. 2 or 3 black powder. The amount loosened by a good shot is 1 to 3 tons. The average consumption of powder is 1 lb. per 5 tons of output. A shot-lighter has charge of the placing and depth of all holes and of discharging all shots.

The rate of work is about eight to fourteen tons per pair per shift of eight hours, in wide work. In narrow work in a six-foot seam a pair averages about one yard per shift.

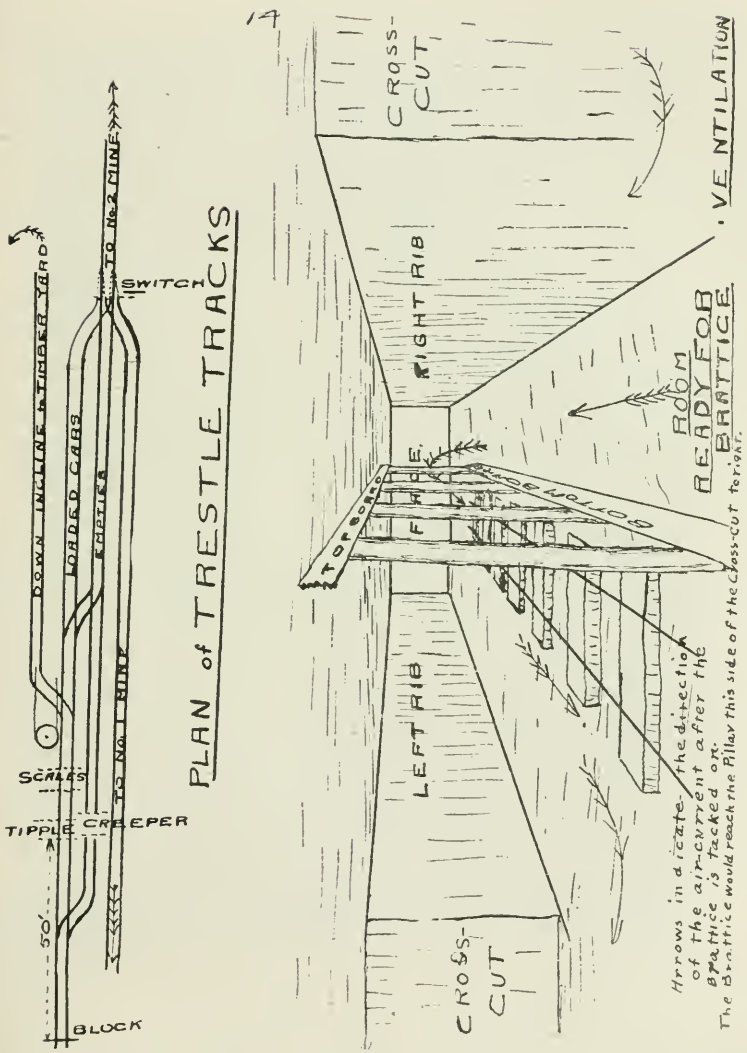
HAULAGE.—The undulating character of the seams renders haulage a difficult problem in engineering.

The main haulage is operated for about 2,000 feet by an electric motor in each mine. The grade of the motor tracks is 2 per cent., rising inwards as far as the first bend in the main haulage road, shown in the plan, after which it is variable. In No. 2 mine the main motor haulage was extended 600 feet by means of an electrically driven stationary hoist. The grade of the track for the hoist varies from 15 to 20 per cent. being too steep for the motor. The hoist is geared to give a cable-speed of two miles per hour. The secondary haulage in each mine is by horses and is under the superintendence of a driver boss in each. The driver boss remains at the landing and oversees the coupling and starting of the motor trips. Each driver hauls, on the average, about 40 boxes per shift, from four working places to the landing—a distance not exceeding 300 feet. It is found to be bad economy to let the round trip for a horse exceed 600 feet.

The arrangement of tracks, switches, scales, tipple and creeper are shown in the plan of trestle tracks (See Plate III).

Two men are required on each motor, a motor man and a conductor. These haul the trip from the landing in the mine, out upon the trestle, and switch it on to the weighing and dumping track, returning with empties. The loaded cars are now uncoupled and pushed forward on the scales by a bankman. A tally-boy removes the tally and reads the miners' number to the weighman, returning the tally to its proper place on the tally-board. The miners have availed them-

PLATE III.


PLAN of TRESTLE TRACKS
DOWN INCLINE IN TIMBER YARD
LOADED CARS
EMPTIES
TO No. 2 MINE
SWITCH
TO No. 1 MINE
SCALES
TIPPLE CREEPER
50'
BLOCK
14
CROSS-CUT
RIGHT RIB
VENTILATION
FACE
TORPEDO
ROOM READY FOR BRATTICE
LEFT RIB
CROSS-CUT
Arrows indicate the direction of the air-current after the brattice is tacked on.
The brattice would reach the Pillar this side of the Cross-cut to right.

selves of their legal right to appoint a check-weighman who overseers the weighing and checking of each box.

After being weighed, the cars are dumped by means of a Mitchell tippler, capable of dumping 10 cars a minute. The tippler is so arranged that the following cars release the wheel-grips of the empty car in front, which then runs down a 5 per cent. grade for a distance of 50 feet, and then switches automatically back on another track, falling 5 per cent. for the same distance, to the side of the tipple. From this point, reached by gravity, the car is pushed by a creeper up a 15 per cent. incline, to a sufficient height to permit it to run forward, under the action of gravity, on the empty track ready for attaching to the next return trip.

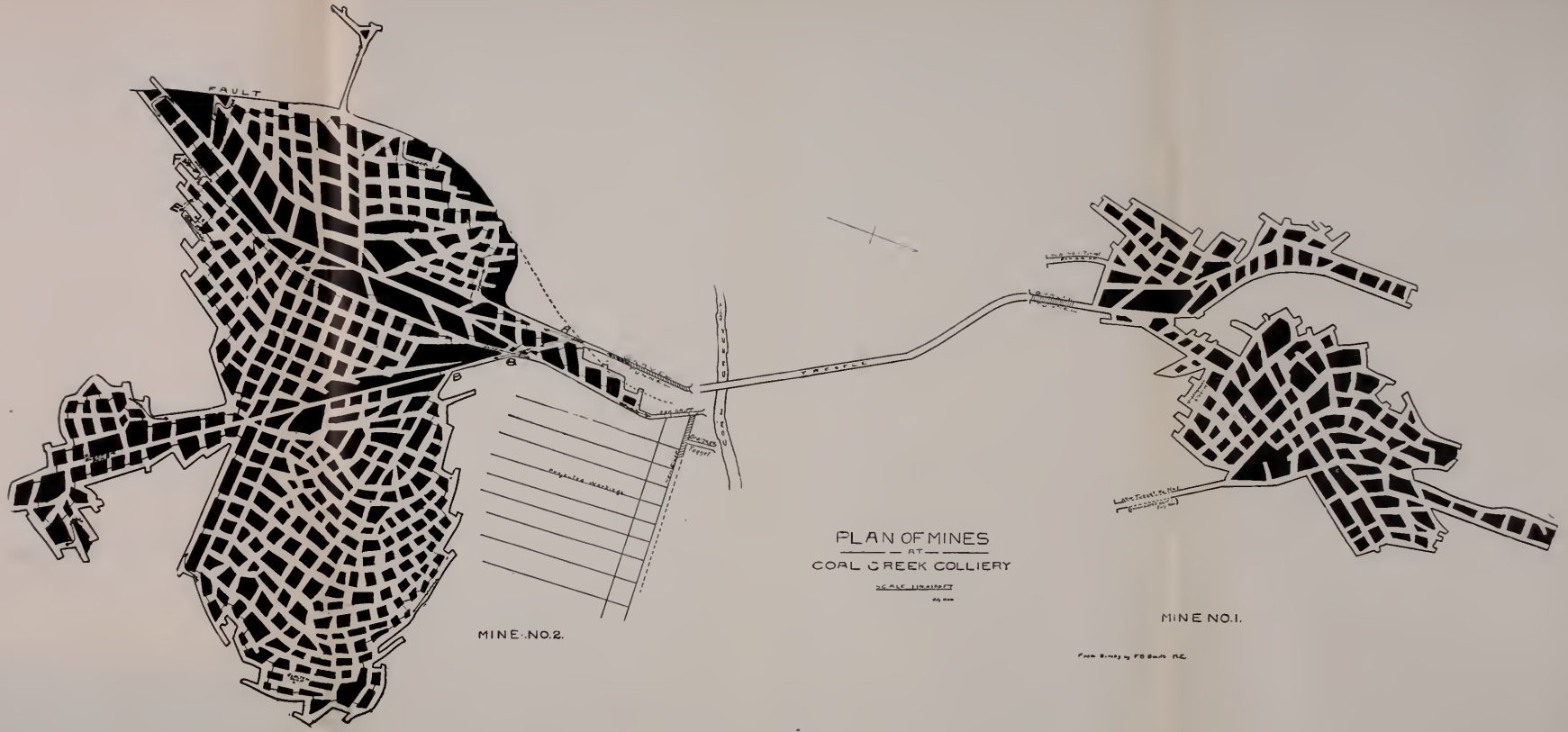
Difficulties.—Owing to the thickness of the seams being worked, there has been no necessity for "brushing" the roof for haulage-roads in either mine.

In No. 2 Mine there have been a few cases of heaving of the floor but these have so far caused but little trouble, being of no great extent.

On the other hand, the undulating character of the strata causes, even on the general line of strike, some very steep grades, which it is practically impossible to overcome by horse-haulage. The haulage on these parts, between the rooms and the landings, presents a series of difficulties which it will tax the utmost skill of the engineer economically to overcome. As already mentioned, one of these long 15 to 20 per cent. up-grades is operated by an electrically driven stationary hoist. A second 20 to 25 per cent. down-grade in No. 2 Mine, is operated by gravity for about 400 feet, being provided with double track, ¾ inch cable, and a drum at the head of the incline, worked by means of a friction clutch.

Timbering.—As the roof in both mines has been very sound, timbering has been a comparatively easy matter. The chief difficulties so far met with, have arisen from slight faults and one slight fall in No. 2. But even these have been secured by the use of a few extra props with ties as cap-pieces. The props and booms are of tamarack and spruce, procured from the neighboring forests. They range from

Coal Creek Colliery—Weighing and Screening Building.



PLAN OF MINES
AT
COAL CREEK COLLIERY

7 inches to 10 inches in diameter. The timbers are set in the usual way, it being rather more than usually important to set the head of the props a little above a perpendicular from the foot of the prop to the roof, owing to the tendency to creep. This causes the prop to tighten in case of a creep, thus offering resistance instead of falling out.

The method of timbering the gravel tunnels will be described later on.

VENTILATION.—Considerable quantities of fire-damp, $C H_4$, are given off in both mines, due probably to the fact of the coal-beds being still almost intact and to their great thickness. Both mines show the natural tendency to become more fiery as the workings extend inwards from the exposed outcrops, and as, in consequence, the depth of covering increases. The problem of ventilation is, therefore, of increasing importance.

Moreover, the altitude, 3,800 feet, gives very low barometric readings of 24 to 25 inches, corresponding to a pressure of 12 to 12½ pounds per square inch. This low pressure greatly increases the amount of fire-damp's given off from the coal. It also increases the volume of air required to dilute the fire-damp and supply the men, in the ratio of 5:4. Besides, the reduced pressure augments the difficulty of exhaustion by fans. Thus, ventilation, as well as haulage and the tendency to creep, will require the closest attention of the engineer.

The splitting system of ventilation is the one adopted, there being at present 2 splits in each mine. The air-courses, splits, stoppings, etc., for No. 2 Mine are shown in the plan, the direction of the air-currents being shown by arrows. The ventilation of No. 1 is similar to that of No. 2.

It may perhaps be interesting to follow one of the splits around.

Referring to the plan of No. 2, we see that the air-current, 50,000 feet per minute, enters the mine by the main haulage road, 6 feet high and 8 feet wide, having a velocity therefore of a little over 1,000 feet per minute. At A, the current is split, one part turning to the right and the other to the left, as shown by the arrows. The air-current in both splits is directed round to the working places and kept from being dissipated through the old workings of the mine by means of the doors

and stoppings indicated by the lines drawn from pillar to pillar. At B, is the first door, as the stopping here is across a haulage road. As a certain amount of leakage is necessary, in order to keep the haulage road from B down the main deep, supplied with air, this door is made of canvas. The use of a canvas curtain also saves the expense of a door-boy. Similar canvas doors replaces the tight-board stoppings wherever the latter would interfere with haulage.

Following the left split around, we come to a typical working place at E (See E on tracing of plan). Here the air would short-circuit and not sweep the gas from the working-face were it not for the canvas stretched from roof to pavement shown by the line a b. The brattice is extended as the working-face is pushed forward, always being kept within about 9 feet of the face. When the room is extended about 60 feet, to c, a cross cut, c d, is made into the next working-place, a tight-board stopping is placed at e f, the brattice is removed, and the air is thus short-circuited through the cross-cut, c d. This is the method of directing the air-current to the face of all rooms and entries. Entries are driven in pairs with cross-cuts at intervals of about 60 feet, one entry acting as the intake, the other as the out-take.

Still following the left split we come to F, where the right split having traversed a similar course, unites with the left in the return drift. At G, is an over-shot, where the outgoing current is made to pass over the left in-coming split.

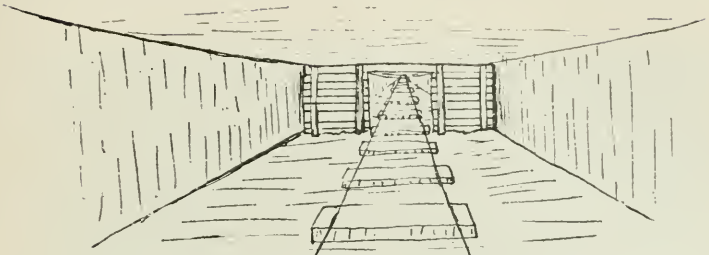
Passing onwards we come to the air-pit. Here a tight door is placed across the return-drift and the air passes up the air conduit, the fan above acting as an exhaust.

This fan is of 8 feet diameter by 4 feet width, with 14 vanes. It is belted to an Atlas horizontal engine, the ratio of the engine and fan speed being 5:8. The fan speed at present is 208 revolutions, supplying 50,000 feet of air to the mine per minute. It is capable of supplying 70,000 to 80,000 feet per minute as occasion arises.

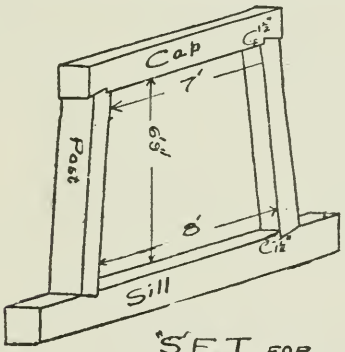
The amount of air required by law is 100 cubic feet per man per minute. The amount in circulation in each of these mines as shown by calculation from the velocity indicated by the anemometer, is more than 300 feet per minute for every man, boy and horse.

Coal Creek Colliery—Slack Bin.

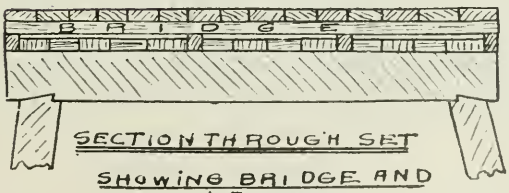
PLATE IV.



FRAME FOR CANVAS DOOR



SET FOR GRAVEL TUNNEL



SECTION THROUGH SET SHOWING BRIDGE AND LAGGING

Light.—The trestle is lighted by 16 pairs of incandescent lamps of 16 candle power. The main haulage roads are lighted by 40 similar lamps of 20 c. p., one lamp being placed at each turn in the road and 3 at each landing. Arc lamps were tried at first, but these proved unsatisfactory as they burned out quickly owing to coal dust.

Naked lights are used in all parts of the mines except those reported unsafe by the fire-bosses. In July, 1900, 40 Clanny safeties were in use but the company keeps on hand a sufficient supply for use by all underground laborers in case of emergency.

Drainage.—Considering the extent of area developed below the drainage level there is but little water. The irregular ground prevents concentration into one or more main sumps. To remove the water met with in the lower rooms of No. 2 Mine, 2 Tripley electric pumps, 1 Sould hand pump and 1 water car are in use. The capacity of the electric pumps is about 20 gallons per minute, each of the 3 plungers working at 60 strokes per minute. Their position is shown in the plan. The small quantity of water met with in No. 1 is handled by 1 electric pump and 1 hand pump. Each of the electric pumps is driven by a 3 H. P. motor.

Surface Treatment.—After being dumped by the Mitchell tippler as above described the "run of mine" coal passes on to the screens. There are 2 mechanically driven shaker screens, 20 feet by 5 feet, with a working speed of 100 strokes per minute, the stroke being 6 inches. Their inclination is 17 degrees. The slack eliminated by the upper screen passes on to the under screen, which, as required, separates it into coking, and smithing or domestic coal. The screens are fitted with interchangeable, steel-wire bottoms of ¾ inch, inch, and 1½ inch, mesh. The large coal is discharged by the upper screen upon a travelling picking-table from which the sorters remove any pieces of bone, slate or stone that may have escaped the notice of the diggers. The picking-table is 60 feet long, 5 feet wide, and travels 40 feet per minute. The discharge of coal is regulated by means of friction gear attached to the driving shaft. The large coal and slack are discharged direct into cars standing on the sidings below. These cars are run down by gravity for filling, and again for coupling into

Coal Creek Colliery—Coke Ovens being constructed.

trainloads, the grade for that purpose being 2 per cent. All the slack goes to Fernie for manufacture into coke. The grade of the spur from Fernie to the mines is 2 per cent.—length of 5 miles.

Power.—Two Polson's fire-tube boilers, locomotive style, of 100 H P. each, supply steam at 100 lbs. pressure to the following engines: Dynamo engine, No. 2 fan engine, machine-shop engine and engine for screens and creeper. Steam for No. 1 fan engine is supplied by a small separate boiler. Two new boilers are being introduced to meet the increasing demands for steam as the mines rapidly develop. One is a water-tube boiler of the Polson make, Heine type, 200 H. P.; the other is a return tube boiler, horizontal furnace, 80 H. P. made by the Jeffreys Manufacturing Co., at Columbus, O. The dynamo is driven by a Polsons horizontal engine. It is a direct-current, constant-potential dynamo of 134 H. P., over-compounded 10 per cent. It supplies a current of 400 amperes on the line at 220-250 volts. The current is conducted into the mines by a figure-8 copper wire (equal to 00 B. and S. gauge) suspended on standard mine hangers. The dynamo supplies electricity for: 3 electric pumps, 2 locomotives, the hoist in No. 2 Mine and the incandescent lights at the surface and in the mines. Details of the boilers, engines, etc. will be given under "Statistics."

The disposition of the surface plant will best be made clear by referring to Photo No. 1.

Development.—Besides the usual driving of narrow-work, at which 40 miners are employed, a new tunnel is being driven to each of the mines. That to No. 1, is a rock and gravel tunnel of 1¼ per cent. grade and is to serve as a main haulage road. Owing to striking a bed of quick sand after the rock had been pierced, excavation from within has been abandoned and has been begun from without. The dotted line in the plan indicates the unexcavated part. The short trestle shown to the right of the old trestle (in Photo No. 1) is for this tunnel. The new trestle is provided with gravity return for the coal-boxes and with an Ottumwa box-car loader.

The new tunnel to No. 2 Mine, (really a slope since it follows the dip) is shown in the plan. The first 60 feet is in gravel, the grade

being 12½ per cent. At this point the tunnel enters the coal, when the grade becomes variable, as the seam is undulating. At 90 feet the drainage tunnel (shown in the plan) was driven. Rooms are to be branched from this slope, along the strike. The timbers used in the gravel tunnel were hewn 10 to 12 inches square and framed in sets as shown in the sketch (See page 27). These sets were placed at right angles to the dip, 4 feet apart from centre to centre. To prevent filling in, the sides and top were tightly lagged, the top lagging being 3 inches thick. The lagging was strengthened, when the tunnel was completed, by placing lining sets midway between the sets above referred to. Owing to the steep grade, this slope will be operated by a separate engine and cable.

Office Work.—Following is a brief account of the staff at the mines with the duties of each: One superintendent, who has complete charge, under the General Manager, of the mines and coke ovens; one assistant superintendent, who has charge of the mines only; 3 overmen, one on each shift, who have control of the ordinary miners and shift-men, but not of those employed in development work, these being under the immediate charge of the superintendent; 1 time-keeper and 1 assistant, who have charge of the store-houses and magazines, issue the time checks, powder, oil, tools and other mine supplies, and keep all the books necessary to account for these; one clerk, whose duties are to keep the "coal-tonnage" book and the "yardage and considerations" book, and to make out the daily report, which, signed by the General Manager is at once forwarded to the Managing Director at Toronto.

At the General Office at Fernie, the General Manager, who, under the Managing Director, has control of the Michel, the Erickson and the Coal Creek Collieries, is assisted by: 1 book-keeper, 1 type-writer, 1 clerk, 1 coal-shipper and weigher, 1 coal agent and 1 surveyor and helper.

A complete survey of the working-places is made once every 3 months and added to the large progressive plan kept at the general office, a tracing of which is immediately forwarded to the Managing Director. Minor surveys are made at shorter intervals as needed.

Coal Creek Colliery—Jeffrey Electric Motor at Entrance to No. 11 Colliery.

PRODUCTION.—About 50 per cent. of the total "whole coal" is at present left as pillars forming an enormous reserve for extraction when the upper seams shall have been exhausted. Of the coal extracted 40 to 45 per cent. is slack, which is entirely utilized for coke, the coke being of the best quality and in great demand.

The average daily output, July, 1900, was 700 tons, the total average cost of extraction and preparation per ton being $1.30. No doubt by this time, with the completion of the two new tunnels this output is more than doubled.

All the coal is of the class known as coking coal, lying between bituminous and anthracite in hardness and containing 80 to 90 per cent. of carbon.

COKE OVENS.—All the slack from the C. N. P. Co's. collieries is shipped to Fernie for manufacture into coke.

The coke-ovens are of bee-hive shape, 12 feet in diameter and 7 feet 3 inches high with open tops. When completed, there will be 500 of them, placed in two double rows, with 3 railway tracks one on each side and one between. The shape, construction, tracks, etc. are shown in Photos Nos. 4, 5 and 6.

The coking-coal is stored in the mammoth, double-decked, self-discharging bin shown in Photo No. 8. The bin has a capacity of 4,500 tons, cost $20,000, and required ¾ of a million feet of lumber in its construction.

The ovens are charged by the steam lorry (an electric lorry was used at first) shown in Photo No. 7, having a capacity of 7 tons of slack. The lorry-track, passing over the oven and under the bin, is of standard gauge, 4 feet 8½ inches.

The average charge of slack per oven is 6½ tons (2,000 lbs.); production of coke per charge, 4.42 tons; percentage of coke, 68; time of burning charge, 60 to 72 hours; average out-put per day, 1.4 tons.

No provision is made at present to recover any of the by-products.

The coke is cooled by watering inside the ovens. Coke thus cooled is said to be superior to that cooled outside the ovens, con-

taining less moisture though the process deteriorates the inside lining of the oven and causes considerable loss of heat.

MARKET.—Both coal and coke have found a ready market and the demand for both is rapidly increasing. The distribution embraces the Territories east to Winnipeg, the Western States and British Columbia. Large quantities have been used by the C. P. Ry. and large consignments have been shipped to the Royal Navy at the Pacific Station. The coke finds a ready market at Trail, Butte, Anaconda and other smelter towns of the West.

TRANSPORTATION.—As before stated, the colliery is situated 5 miles from the Crow's Nest Branch of the C. P. Ry., with which it is connected by a spur of 2 per cent. grade. By means of this railway there is direct communication east and west but there is the serious drawback of high freight rates, resulting from lack of competition. Large consignments of coke, for smelting purposes, are shipped to the Western States via the Lethbridge and Great Falls Narrow Gauge Railway, 200 miles in length, which necessitates transhipment from broad to narrow, and again from narrow to broad gauge before reaching its destination. Application has been made for a charter for a branch railway connecting Fernie with a spur to be built from Jennings on the Great Northern.

It is highly probable that Fernie will become a great smelting town as it has, in addition to coke, an unlimited supply of limestone in the mountains near at hand.

Thus are being opened up, the vast resources of one comparatively small part of the unlimited mineral wealth of our Dominion.

STATISTICS.—I. *The Motor:* (See Photo No. 3). Length, 10 feet 6 inches; height, 3 feet 4 inches; width, 4 feet 7 inches; wheel centres, 3 feet 4 inches; gauge, 3 feet; driving wheels, 2 feet diam.; weight, 10 tons; H. P., 70; possible load, 17 boxes of 3,000 lbs. each; average loads, 13 boxes; speed, 8 m./h.; made at Columbus, O., by the Jeffrey M'f'g. Co.

II. *The Coal Boxes:* Made by blacksmiths and carpenters when not employed on repairs. Following are details: Capacity, 1 ton

COAL CREEK COLLIERY—Coke Ovens at Fernie in course of construction.

or with top setting (or "pitchings"), 3,000 lbs.; tare, 1,100 lbs.; material of box, 1½ inches spruce; length, 5 feet; depth, 2 feet; width, 4 feet; length over trams, 6 feet 6 inches; frame, 2 lengthwise pieces, 4 inches x 6 inches, acting as bumpers, and 3 cross-pieces, 4 inches x 6 inches. *Mountings:*—Front strap, 2 inches x ⅝ inch; middle strap, 2½ inches x ¾ inch; inside angle-iron, 3 inches by 1¼ inches; hinges for end dumping doors, 2½ inches x ½ inch x 23½ inches; strap round 2 sides and one end of box at top, 2¼ inches x 1¼ inches; wheels, Hadfield's patent, cast-steel, 12 inches diameter, 7 spokes; axles, 1⅞ inches diameter; wheel centres, 1 foot 10 inches; gauges 3 feet; wheels rotate separately on axles; total height of car above rails, 3 feet 3 inches; couplings, 3 links of 1 inch round iron and 2 clevises of 1¼ inches iron. Spragging is used by the drivers instead of brakes.

III. *Tracks:* Gauge, 3 feet; ties of main haulage roads, 5 feet x 4 inches x 6 inches—2½ feet from centre to centre, firmly spiked and fish plated. Motor rails, 40 pounds to the yard; stall rails 25 pounds to the yard; switches and frogs, made at colliery shops from F. B. rails. No. of track layers, 2 on each shift in each mine, 12 in all. Tools used: 1 combined pick and claw, 1 spike hammer, 1 shovel, 1 bar, 1 track-gauge, 1 "Jim Crow",—(for bending rails)—for for each mine. Also one track-cleaner is employed.

IV. *Engines:* *(a) Dynamo Engine:* Horizontal engine of Polson make; cylinder, 16 inches diam.; stroke, 16 inches; speed 225 strokes per minute; I. H. P. 150; cut-off, automatic, cutting-off light at 1/6th stroke; loaded from 1/6 up.

(b) No. 1 Fan Engine: Nagle horizontal engine; cylinder, 14 inches diam.; stroke, 16 inches; speed, 62 strokes per minute; cut-off at ¾ stroke; B. H. P., 40; steam supplied by a 45 H. P. loco-tubular boiler with working pressure of 50 pounds per square inch; engine slowed down once in 2 weeks to fill oil-cups of crank and cross head.

(c) No. 2 Fan Engine: Atlas horizontal engine; cylinder, 12 inches diam.; stroke 14 inches; cut off at ¾ stroke; speed, 130 revs. per minute; steam supplied by 2 inch piping, from power-house boilers

500 feet distant—being first dried in an upright receiver; pressure, 100 pounds per square inch; engine stopped about 3 minutes every 24 hours to fill oil-cups of crank and cross head.

(d) Engine for Surface Plant: Upright; cylinder, 10 inches diam.; stroke, 12 inches; cut-off at ¾ stroke; I. H. P., 22; steam supplied by power-house boilers 100 feet distant—not dried before using.

(e) Machine shop Engine: Upright; cylinder, 6½ inches diam.; stroke, 9½ inches; cut-off at ¾ stroke; speed, 130 revs. per minute; I. H. P., 10; steam supplied from power house boilers.

V. *Boilers:* In use in summer of 1900—2 Polson's fire tube boilers, locomotive style, of 100 H. P. capacity each, supplying steam at 100 pounds pressure to the engines mentioned above; diam.; 4 feet 6 inches; length, 23 feet; diam. of tubes, 3 inches; consumption of coal, 4 to 5 tons each per 24 hours; draft for each, 24 inch stack, 70 feet high. Two additional boilers were being added, one of the Polson make, Heine type of 200 H. P. capacity; the other of 80 H. P. capacity and made by the Jeffrey M'f'g. Co.

VI *Costs etc:* Miners are charged for oil, powder, squibs and lost or broken tools, but not for tools and repairs.

Costs, last summer (1900) were as follows: Oil, 80c. to 90c, per gallon, powder, 15c. per pound, squibs, $1.00 per 100. Not more than 4 pounds of powder are allowed to a pair at one time.

The prices paid for work were as follows: Per ton, in rooms with naked lights, 60c. with closed lights, 80c. In narrow work the usual tonage is paid, also yardage, and $1 per set for timbers. In both wide and narrow work, "considerations" are allowed by the Superintendent for special difficulties—as for water, stone, slight faults or branching stalls. The allowance for branching a stall is $1.25; other "considerations" are settled as they arise.

VII. *Machine shop Fittings:* One Williams lathe; one drilling machine; two emeries; four jackscrews; three sets bolt dies; one set pipe dies; pipe vise; and the usual hand tools for keeping the engines and

Coal Creek Colliery—General view of Coking Plant at Fernie, B.C.

other mine machinery in repair. Three mechanics are employed besides three electricians, two engineers and one on repairs.

VIII. *Smithy:* Five blacksmiths are employed as follows: 1 steele-sharpener who sharpens all picks, augers, wedges and other tools used by the miners; 1 blacksmith and helper for new work; 1 blacksmith and helper for shoeing and repairing. All steel and iron used, together with the scrap, are weighed and charged to the job for which used; The number of hours spent on each job is also charged against that job.

IX. *Labor:* The average wages earned by the miners is $3 to $4 per day; general mine labor costs $2 to $2.75 per shift; general surface labor, $1.75 to $2; boys receive $1 to 1.75.

About 350 men were employed at the mines (July 1900), distributed as follows: (*a*) *Above Ground*, 2 weighmen, 2 tally boys, 6 bankmen, 6 slate pickers, 12 car loaders, 2 trimmers, (for trimming slack cars and box cars), 5 yardmen, 3 blacksmiths and 2 helpers, 2 carpenters and 1 framer, 3 mechanics, 3 on electric works, 2 firemen, 2 fan tenders, 2 engineers for screens, 3 prospectors, 8 on construction work 1 time keeper, 1 helper, 1 clerk. (*b*) *Underground*, (about 290 in all); 3 overmen, 5 fire.bosses, 2 shot-lighters and 3 bosses), 6 track-layers and 6 helpers, 2 driver bosses, 18 drivers, 4 motormen, 4 conductors, 2 on electric hoist in No. 2 mine, 6 landing tenders, (3 men and 3 boys), 10 pushers and incline men, 12 pumpmen, and bailers, 3 shiftmen, (sparemen on each shift for emergencies, e. g. of water), 4 timbermen, 12 on new rock tunnel work, 40 miners on yardage (narrow work), 120 ordinary miners in rooms. Length of shift under ground is 8 hours "from pit's mouth to pit's mouth."

Algoma Mining Freaks.

By CHARLES BRENT, M.E., Rat Portage.

I was engaged as assayer, some years ago, by a Canadian Company who were operating on the North Shore of Lake Superior. The Manager, a school teacher of years and experience, was driving a tunnel into a granite hill. The tunnel was lower at the breast than at the mouth, and as one shift only was worked there was an accumulation of several feet of water during the night. I have a very vivid remembrance of all hands and the cook packing water out of that tunnel every morning. I ventured to suggest a hand pump. The Manager looked at me askance as if he thought I was infringing on his prerogative and making myself officious. After a lapse of several days Mr. Manager announced that he had sent for a pump and that it would arrive at the station that evening. I was ordered to go after it, and on asking for some men to help me carry it to the boat was informed that I could carry it myself. I went off, full of anticipation, which was more than satisfied when I saw the pump. It was a good sized syringe, intended for spraying fruit trees or bailing out a boat. The comments of the "Cousin Jacks" when I appeared at the mine with the pump over my shoulder it would not be proper to reproduce in this paper. I may state that the Company spent $25,000, have two tunnels aggregating 180 feet in length, shipped the whole of the high grade ore to the home office in two cigar boxes, attempted to ship several tons of lower grade in an ancient barge, caulked with rags and blue clay, which promptly went to the bottom in spite of the heroic efforts of the "Cousin Jacks," who swam ashore. "A complete assay outfit" had been purchased, according to the prospectus of the Company. I found this to consist of two plumbago crucibles, one muffle, Battersea, size F, a pair of apothecaries' pocket scales with pans of horn and string suspension, and a set of apothecaries' weights. This Company "went broke," and you couldn't get a cent

for mining in Algoma from any of them or any of their friends or associates. They say the country is no good. Do you wonder?

Some years later I was assayer at one of the noted silver mines of Algoma. There was in the mill yard a unique collection of rusty scrap-iron, the cast-off devices for silver extraction thrown aside during the evolution of the mill. This mill was a law unto itself; the processes of natural selection and survival of the fittest were allowed to go on by the manager in all their native beauty, untrammeled by any of the lessons of experience. The result was a machinery museum in which one could see something new every day, driven by a fire-eater of an engine that achieved the distinction of clearing more land than anything of the h.p. ever invented before. I remember on one occasion remonstrating with the new mill superintendent, a supposed "cracker jack" from Colorado, when the tailings soared ounces above the headings, he called me on one side and informed me that he had never seen a silver mill before. I admired his candor, and as he was a decent fellow, the extraction as returned to the office was not so bad as it might have been. This mine extracted half a million ounces in five years and finished up "in the hole." I heard one of the stock holders of this mine, only the other day, strongly advising one of his friends not to put any money into Algoma mines. Do you wonder? While employed at this mine I used to wander once in a while to a neighbouring mine that was noted for the number of "nuggets" of Argentite or "black silver" found in the veins (I saw one mass of 40 lbs). I sauntered into the blacksmith shop one day, and saw the manager preparing to melt some "nuggets" in a babbit ladle. I was immediately interested. The ladle was well filled with several pounds of argentite, the helper blew the fire lustily, the mass started to melt, and—there was no bottom in the ladle, and the forge became, for a foot or two in depth, highly argentiferous. There was some profanity, but after things had cooled off a little I suggested trying the experiment in a black lead crucible, mixing the remainder of the argentite, which was mostly dust and small fragments, with some charcoal and nitre. It was a big thick pot, and nothing happened at first, but as soon as it got warm I saw some-

thing attractive outside. There was a sharp report a moment later, my very fair substitute for gunpowder had gone off, the blacksmith and his helper were full of coke and plumbago, and the manager was in the blacksmith's tempering tub, digesting his second lesson in the metallurgy of silver. This mine put up a "saw mill" for a stamp mill, extracted 350,000 ounces in two years, and ended up in the hole, leaving the working men with six months' arrears of wages. Why ?

Not many years ago I was engaged to superintend a new gold mill in Algoma. This mill, a few weeks previous to my engagement, was reported on, for a consideration, by one of the best known *military* metallurgists of the district, and pronounced a first-class plant for the extraction of gold and silver values from the ores of the country. The stock holders were much elated, and looked forward with fond anticipation to the 50 per cent. dividends promised them by the promoters of the scheme. Let me describe briefly my first visit. It was a cold winter's day, the building was built of rough lumber covered with corrugated iron, the heating arrangement an occasional whiff of warm air from the boiler room, the temperature a little above freezing. There were two crushers, each of unknown species ; one was running merrily and was being "fed with a spoon." The other was idle and carried on its pitman a block of ice as much as a man could lift. The place was full of dust, but as I wanted to get an insight into the ice business I waited. In a few moments the crusher man felt the bearings of his busy machine, hastily threw off the belt, changed the block of ice from No. 1 to No. 2, started up No. 1, and all went merry as a marriage bell, until the next time. The ore, after being crushed, was elevated 40 feet and then allowed to run back to the floor on which the crushers were situated, whence it was fed by hand to a pair of pulverizers which were doing their best to grind themselves to pieces on the exceedingly hard quartz with which they were being fed. The machines were, without exception, the best contrivances for grinding iron by means of quartz I have ever seen. When I tell you that the normal wear was between three and four pounds per ton of quartz you will see that I am not exaggerating.

The pulverizers were wet grinders, and the pulp, on issuing from the screens, passed over a series of cast iron riffles set in a sheet iron trough. All the gold saved in the mill was caught in the first two feet of these riffles, and more than 50 per cent of the values were allowed to escape. The tailings ran into four large grinding pans, followed by two agitators and a pair of eight foot settlers. All of these were whirling around without a pound of mercury in them, doing no work, their uses unknown to anyone in the mill, driven by a huge fire-eater of an engine using seven cords of wood per 24 hours. The average crushing was 5 tons per day. A large reverberatory, the roof of which fell in the first time it was fired, and a colossal retort, capable of handling all the amalgam in Canada, were prominent features of this unique plant, which, after various vicissitudes, stands idle to-day, a monument to the gullibility of the public and the success of a pair of unscrupulous fakirs.

The crying need of this section of the country is a school of mines that will turn out trained men who will not need to complete their education at the expense of their employers. We have a country of marvellous resources, the development of which is being severely retarded by the gross incompetence and fakirism of the men who have been in charge of many of our mining ventures. The public need to be educated to the fact that miners and metallurgists are not born, but made, and that it is unsafe to entrust the management of a mine to a man who often possesses no other qualification than a relationship to some of the directors.

Would a trained man drive a tunnel 400 feet into a hillside to attain a depth of 30 feet, or, having a good natural slope for a mill site, deliberately dig a cellar and put his mill into it endwise? Would a sensible man sink a prospecting shaft 12 feet by 16 feet, or put up a mill on the top of a hill where there never is any water except when it rains, or place it in a swamp so low that the tailings flood the wheelpit of his engine three weeks after starting? Would any man possessing ordinary common-sense spend thousands of dollars sinking shafts on the indications of a divining rod, or build a first-class stamp mill and three miles of railroad without one foot of development on

the mine? What would you think of an assayer who makes "Fire" assays, "fires the samples out of the window," and coolly writes out his certificate of assay, or who finds gold values in brick-dust, rock-salt, blue clay, or "any old thing"? A good many thousands of dollars were spent recently in our country on extensive borings in blue clay at the bottom of a lake, all on the strength of results of "Fake" assays. What do you think of a mining engineer, who on the strength of a couple of examinations condemns a whole district and says it is no good? A mining engineer possessed of common sense, divides the properties in any country into two classes, those he has examined and those he has not examined. If he has examined a property, his examination and report is the property of someone who has paid him for his work, and he has no right to open his mouth about the matter. If he has not examined a property he knows nothing about it and can say nothing. A man came into my office some time ago with a new cyanide process. He proposed to boil the crushed rock with cyanide and some special dope he had invented. He wanted to have the use of my laboratory for his experiments. I recommended him to experiment in a kitchen, and advised him to boil his rock with red cabbage before treating with cyanide. I told him I thought he would get a better extraction. He thanked me, but would not speak to me next day. I have before me an advertisement of an Algoma mine, which states that a shaft 100 feet deep with a cross-cut 100 feet long at the bottom exposes 1,500,000 tons of ore! I should think it exposed the ignorance of the writer. Another concern professes to have a shaft 300 feet deep, and in their advertisement say "Remember we have ore enough to keep fifty 40-stamp mills pounding out gold continuously, not only during the lifetime of our youngest stockholder, but during the lifetime of his childrens' children." This is equal to the speech made by another of our managers to his stockholders in London. He mentions nothing less than 30dwt. ore, but admits that some runs 12½ozs. He is glad that a new issue of stock is being made, so that he and his assistants may have a chance of investing and of "Putting up our hard sovereigns with yours," as he enthusiastically threatens to do. I hope that other sanguine gentlemen may have better luck than

this last one, who shut down his mine a couple of months after making his bluff.

In concluding this paper, which is made up mostly of chaff, but which may afford some kernels of truth on reading between the lines, I desire to protest against the dishonesty and incompetence that have been the cause of so many failures in mining in our country. There is enough natural risk in mining to satisfy the ordinary desire of the votaries of chance, and we must eliminate the ignorance and charlatanry too common in this country before we can hope to place mining on the business basis it should occupy.

The Analysis of Corundum and of Corundum Rock.

By Dr. W. L. Goodwin, Kingston, Ont.

Since the discovery of corundum in Eastern Ontario the writer has been obliged to pay considerable attention to the analysis of the rock in which the corundum occurs, and particularly to the determination of the percentage of corundum, of iron, and of silica. Each of these determinations presents difficulties of its own.

Determination of Corundum.—The percentage of corundum can be arrived at in three different ways, two of which are fairly accurate, viz: (1) The hydrofluoric acid method, and (2) The specific gravity method; while the third is only approximate, viz: (3) separation by heavy solution. These methods have all been used in the laboratories of the School of Mining, and (1) and (2) have been shown to give concordant results. Details of the separation by hydrofluoric acid may be of service.

The Hydrofluoric Acid Method.—Hydrofluoric acid attacks corundum very slowly at temperatures up to 100° C, but more rapidly at higher temperatures. On the other hand it quickly disintegrates the minerals which accompany corundum. The effect of temperature is shown by the following results, which were obtained by treating the ground sample in a platinum crucible heated by a small Bunsen flame. The sample was moistened with sulphuric acid, covered with sufficient hydrofluoric acid, and evaporated until fumes of sulphuric acid appeared. The soluble matter was washed out and the insoluble corundum ignited and weighed. The samples were all alike. The percentages of undissolved corundum were 83.58, 89.02, 81.63, 80.06, 69.75, 77.48, and 74.77. The variation is very marked. This sample contains 93.68 per cent. of corundum, as shown when the evaporation is carried on on a steam bath, followed by heating with a Bunsen burner until fumes of sulphuric acid just appear. For this determination it is not necessary to grind the sample very fine. Crushing in a

'diamond' mortar is sufficient. Two samples of another lot gave 95.64 per cent. and 95.38 per cent. To test the insoluble residue from another specimen, it was fused with $Na\ H\ S\ O_4$, and from the dissolved melt, the alumina, etc. were precipitated by ammonia, with the following results :—

Insoluble in H F and $H_2\ S\ O_4$	92.16 per cent.
Alumina, etc. in this insoluble part. ..	92.16 "

To test the applicability of the method to corundum rock a mixture was made of 20 per cent. of pure corundum and 80 per cent. of tailings containing at most a trace of corundum. This yielded on analysis 20.32 per cent. insoluble in H F and $H_2\ S\ O_4$. Three samples from 500 lbs. of corundum rock gave

	Insoluble in H F and $H_2\ S\ O_4$.
I.	21.01 per cent.
II.	20.51 "
III.....	19.28 "

Sample I. was treated without previous ignition. Sample II. was ignited, and sample III. was ignited for a longer time than II. Ignited corundum was shown by other experiments to be attacked to a greater extent than when not ignited. This is perhaps due to the disintegration of the granules by the escape of the combined water, which amounts in a 93 per cent. sample to about 1.5 per cent.

Determination of Corundum by Specific Gravity.—This method is applicable to the concentrates freed from magnetite. The approximation to the results of the chemical method is very close, as shown by numerous experiments. For example, the specimen which by chemical analysis showed 93 68 per cent. of corundum, gave 93.71 per cent. by specific gravity. The calculation is made on the basis of a specific gravity of 4 for the corundum and of 2.7 for the impurities (mostly feldspar).

Determination by Separation with Heavy Solution.—By this method the results are only approximate, as the corundum carries down adherent feldspar and mica, thus giving too high a percentage of corundum.

For the sample already mentioned the following are the comparative results by the three methods:

I.	By chemical analysis	93.68
II.	By specific gravity	93.71
III.	By heavy solution	95.23

Determination of Iron and Silica.—The principal difficulty here is to grind the sample finely enough without picking up iron from the mortar. Experience has showed that a considerable percentage of iron is added by crushing in a 'diamond' mortar. Attempts were made to estimate this and to apply a correction, by estimating the iron soluble in acetic acid, and calculating this as metallic iron derived from the mortar. The following results were obtained:—

	Fe dissolved by Acetic Acid.
Sample I.	0.57 per cent.
" II.	0.32 "
" III.	0.20 "

This method was abandoned in favour of crushing and grinding a weighed quantity of the grains a little at a time in a large agate mortar closely covered with paper, and finding the gain in weight. In this sample both iron and silica can be estimated, as the gain in weight can be taken as silica. To illustrate the magnitude of this correction the following will suffice:—

	Weight of Sample.	*Gain from Mortar.*	*Percentage Gain.*
1.	0.4702	0.0039	0.83
2.	1.0000	0.0122	1.22
3.	1.0000	0.0073	0.73
4.	1.0000	0.0029	0.29
5.	1.0000	0.0034	0.34
6.	1.0000	0.0084	0.84
7.	1.0000	0.0211	2.11
8.	1.0000	0.0106	1.06
9.	1.0000	0.0209	2.09

Nos. 1, 2, 3, 6 and 8 are high grade corundum grains.

Nos. 4 and 5 are corundum rock containing about 20 per cent. of corundum.

Nos. 7 and 9 are pure corundum.

The difference in the abrading effect on the mortar is marked.

The sample is fused with $Na\ H\ S\ O_4$, as recommended by Lawrence Smith, and dissolved. The iron is estimated by titration in the soluble portion. The insoluble portion is ignited and weighed as $Si\ O_2$. As a check, the silica may be volatilised by H F and the residue, if any subtracted.

Corundum is now being produced at Combermere by the Canada Corundum Co. of a very high grade, viz. 95 p.c. corundum. When it is remembered that manufacturers have heretofore been satisfied with an 80 per cent. product, the outlook for the Canadian industry seems very bright.

Notes on the Oregon Nickel Prospects.

By Dr. A. R. Ledoux, New York.

Nickel, like tin, is a metal found everywhere in the United States, but mined nowhere in any quantity to-day. It is associated with chrome-iron ores in many of the northern States; with sulphides in Connecticut, New York, New Jersey, and notably in the formerly prosperous mines of Lancaster Gap, Pennsylvania.

For years nearly all the nickel produced at this latter mine was bought by the United States Government for coinage purposes, but to Mr. Joseph Wharton we owe the demonstration of how large a number of useful articles can be made from the pure, unalloyed nickel. The commencement of the age of manufactured nickel dates from Mr. Wharton's exhibit at the World's Fair in Vienna in 1873.

Since the practical exhaustion of the ores of Pennsylvania, and the discovery of the great beds of Sudbury, the United States has been relying on the Canadian product for its nickel. In the beginning the copper nickel mattes of Sudbury were sold to different buyers, principally in Europe. The owners in the meanwhile expended very large sums of money to discover a process commercially efficient by which the mattes could be refined and the nickel separated either in Canada or elsewhere on this continent. It was not until the successful experiments of Col. Robert M. Thompson, of the Orford Copper Company, that the Canadian nickel found a ready market throughout the world in competition with the powerful nickel syndicate controlling the principal mines of New Caledonia. I observe in the statistics published by the Canadian Mining Review, in March, 1901, that Canada and New Caledonia each produced approximately 3,700 metric tons of nickel in the year 1900.

The pyrrhotites of Sudbury have been well described by members of the Canadian Mining Institute, but it has occurred to me that it would be interesting for you to hear something of the Oregon deposits, about which much was written from the political and speculative standpoints a few years since:

These deposits occur upon what is known as Big Piney Mountain, situated near the Southern Pacific Railway in Douglas County, Oregon, some 235 miles south of Portland. The nearest town is Riddles, consisting of some 50 to 100 buildings with stores, hotel, etc., lying in a beautiful green valley everywhere fertile and blest with the moist temperate climate of the Northern Pacific Coast States,—living being very cheap. During the greater part of the year considerable rain falls, but snow does not lie for any length of time excepting upon the summits of the mountains.

The range to which Big Piney Mountain belongs is an isolated cordillera, lying between the Cascade Mountains on the east and the Coast Range on the west. This particular hill rises sharply to the west of the Railroad at Riddles, attaining an elevation of some 3,600 feet above the sea. The nickel ore occurs near the summit of the hill, and for some 2,500 feet below the summit forming a mantle which covers the southerly and easterly slopes. The foot-hills are largely wooded with pine, cedar, and fir. In the valleys are oaks, ash, maple, etc. The ownership of the numerous claims which have been located, is divided between two corporations, neither of them operating at the time of my visit in 1900.

It is well known that there are three principal types of nickel ores. The sulphides have already been mentioned. There are Arsenides, such as are found in considerable quantities in Nevada and elsewhere, but from the silicates which occur in New Caledonia half the nickel of the world is produced.

The ores of Oregon belong to the same type, and in appearance and occurrence resemble closely the New Caledonian. The comparative composition of the Oregon and New Caledonian Ores is shown in Dana's Mineralogy as follows:—

	SiO_2	NiO	MgO	H_2O	$Al_2O_3Fe_2O_3$
New Caledonia..	37.78 p.c.	33.91 p.c.	10.66 p.c.	15.83 p.c.	1.57 p.c.
" " ..	35.45 p.c.	45.15 p.c.	2 47 p.c.	15.55 p.c.	0.50 p.c.
Oregon	40.55 p.c.	29.66 p c.	21.70 p.c.	7.00 p.c.	1.33 p.c.
"	44.73 p.c.	27.57 p.c.	10.56 p.c.	15.86 p.c.	1.18 p.c.

The Geological relations of these deposits to the country rock is thoroughly demonstrated by the amount and character of work which has been done in the vicinity, and may be outlined, untechnically, as follows :—

Overlying the granites and the older limestones and other stratified rocks are beds of coarse igneous breccia, not only the cementing mass but its ingredients being of igneous origin. Up through and overflowing these conglomerates has been an eruption of peridotite. This rock contains as its universal constituent the mineral olivine, which has nickel for one of its components. It is probable that the whole mountain mass of Old Piney, at least on the southern and eastern sides would average 0.25 per cent. of nickel. The abundance of rainfall and other oxidizing influences have thoroughly altered the surface of this peridotite, not only by oxidation but by replacement until an area of several square miles has become covered by a layer varying from a few inches to twenty feet, and probably averaging ten feet thick, of what might be called a gossan of porous, soft serpentine, full of cavities and looking not unlike a coarse coral. The sepentine matrix often shades off into silica, occurring in bands and veinlets, frequently appearing as chalcedony. Cavities in this porous rock and some of the veinlets have become filled in part with chrome-iron ore, iron oxides and the nickel silicate. After the rock has dried, the iron oxides and nickel compounds are readily shaken out as dust if two pieces of ore are struck together, or if the mass is struck by a hammer, or shattered by a blast.

It is obvious at a glance that the nickel in the peridotite has been concentrated in the process of alteration, which alteration, as stated, may extend from a few inches to twenty feet in depth. It is interesting to know that there is still going on a concentration or segregation of nickel in dumps which were formed a few years ago, during the progress of prospecting. On digging through one of those I found a distinctly banded structure to the dump and a stratum of excellent ore in a band three inches thick, lying immediately upon an impervious bed of iron clay which had also been leached out of the ore above, thus forming an impervious bed upon which the nickel ore rested.

As to the extent of the deposit, it would be very conservative to consider it to be a layer of ten feet thick, and covering a square mile. It is one of the few places which justify the promoter's pet phrase of "millions of tons in sight." There are probably one hundred openings, either tunnels, pits, or shafts scattered over the entire area of nickel-bearing ground. These openings have not shown a thickness of over twenty feet at any point, and in every case, whether by vertical sinking or tunnelling, the cap of enriched ore is soon penetrated, soon yielding to the low grade peridotite. The line of demarcation is usually sharp and well defined.

With a view of ascertaining the average grade, I took a large number of samples, carrying them on horse-back to head-quarters and breaking them down at my leisure. As my visit was for private interests, I do not feel at liberty to give definite figures; certainly not to mention the names of any particular claims examined, but reference to my assay book shows nickel determinations on samples varying from 1.23 per cent. of the metal to 9 per cent.,—the great mass of the mountain being low grade. Most of the better class of ore has been shipped to New York, running about 7½ per cent. of nickel. The most extensive working is known as Oregon Tunnel. This enters the steep hill side, passing through some twenty feet of ore, then suddenly entering the unaltered rock. For 250 feet this hard rock shows seams and crevices filled with green streaks carrying little nickel, and then for another hundred feet the tunnel is in practically barren ground, hard as flint.

It is interesting to note one possible exception to the rule that the ore occurs only in this gossan form. On one of the claims which I visited, there was what really looked like a vein cutting not only the surface gossan but the peridotite as well, this latter rock being shattered and almost slaty in the vicinity of the fissure, this vein being some two feet wide, and giving a fair assay of nickel. It is from this vein that considerable of the ore shipped to New York was taken. There were numerous tunnels from one hundred to two hundred feet in length, but all had the characteristics of the 350 foot tunnel above described.

With a view of suggesting the best means of treating this ore I had made a complete analysis of the hand-sorted mineral from the vicinity of the so-called vein, the result being as follows:—

	Per cent.
Silica	59.44
Sesquioxide of Iron	6.40
Alumina	0.41
Manganese Peroxide	0.33
Lime	1.11
Magnesia	16.27
Sulphuric Acid	0.30
Arsenious Acid	0.60
Nickel Oxide	8.23
Loss on ignition	1.00
Undetermined chiefly Potash and Soda	5.91
	100.00

It will be observed that this ore does not differ materially from the New Caledonian product, so that if enough 7 per cent. ore can be obtained it can be handled just as is this new Caledonian ore, but the future of the property will probably depend upon the ability to handle the low grade material without sorting. Nowhere should there be cheaper mining, as the deposit is superficial and so rotten that it could be excavated by a steam shovel with little assistance. If iron sulphides containing gold, or copper sulphides can be found in the vicinity, the ore could be readily smelted into a matte, carrying all the metals of value, the subsequent treatment being such as is now given to the Sudbury product.

There is a possibility, also, that the methods of magnetic separation, which are now being applied successfully to low grade metallic sulphides, such as zinc blende carrying small percentages of iron, can also be applied to these nickel ores; if the mineral may perhaps be simply crushed, dried and sized, the magnet separating the oxide and silicate and the iron from the quartz, and subsequently separating the nickel from the iron, in a field of different intensity. Experiments are being made in this direction.

In closing I venture to record my opinion that some of the nickel deposits of the United States need only the stimulus of an export duty on Canadian nickel to become regular producers, and to state that the mere agitation of the question of an export duty has brought experimental cargoes of Australasian and Norwegian nickel ores to New York for smelting.

Having demonstrated the fact that these ores can be handled economically in New York, other contracts are being entered into, so that somewhat to the surprise of all concerned the United States finds itself independent of the Sudbury ores should it become necessary to do without them. It must not be forgotten that the freight from New Caledonia to New York, being all by water, is always quite as low as are the railroad rates from Sudbury and can be made lower yet by chartering vessels for a round trip. There has recently been considerable talk of a bounty on Canadian metallic products. When Canada offers a bounty she stretches forth her hands in welcome to the miners of all lands : when she imposes an export duty, thus shutting the door in their faces, she must not be surprised if other doors now open are closed to her products in turn.

The Duty of Stamp Mills in Crushing and Amalgamation.

By Courtenay De Kalb, M.E., Kingston, Ont.

It is with reluctance that I venture to speak upon this important subject, for which I am not aware of possessing any special fitness. I enter the field only upon the solicitation of our Secretary, in the hope that I may stimulate others to offer the fruits of their experience in discussion. I have used the stamp mill on a large variety of ores, crushing for amalgamation, for amalgamation and concentration, and for cyaniding without amalgamation. The latter I have come to regard as ordinarily of very doubtful expediency, to say the least, for I do not think anyone will maintain that the stamp mill is an economical crushing device. There may be exceptions to this, however. For example, sectional machinery for crushing is not usually satisfactory. This applies to rolls, Huntington mills, and other roller mills, of large capacity. The smaller sizes are less difficult to keep in repair, but their consumption of power is large in proportion to the work done. Sectional stamp-mills, on the other hand, are eminently successful. Accordingly they would be justifiable for crushing for cyaniding in a remote district where heavy pieces of machinery could not be transported. Again, crushing in rolls is most efficiently done on dry ores, unless the ores are singularly free from aluminous or sericitic matter. If the ores were very wet it might prove too expensive to dry them. It rarely pays to dry ores when extra fuel must be burnt for that purpose. If it cannot be done by waste gases from the boilers, then it will in all probability have to be abandoned. Here, then, is an argument for using the stamp-mill merely as a crusher. In passing I may add that crushing finer than one millimetre (about No. 16 mesh) in rolls is not economically possible. Hence, in crushing for cyaniding, the crushed product must be sorted in hydraulic classifiers, the first spigot-discharge being then reground in some other type of mill. For this purpose I have found either the Huntington mill or the Krupp ball mill suitable.

The tendency of the stamp mill is to make an excessive quantity of fines. Under ordinary working conditions the percentage of the total ore fed which will be crushed finer than No. 100 mesh will vary between 28 per cent and 40 per cent. I have found about 32 per cent to be near the average. All that prevents the production of a larger proportion of fines is the masking of the blow upon the smaller particles by the crushing of the larger particles on the die. I am inclined to believe that very nearly all the fines are produced in the crushing of the larger particles, those which rest upon the die and protrude above the general mass of ore upon it, especially where low discharge is employed. It may not be commonly known that the crushing in a stamp mill is accomplished mainly by the reaction from the die after the stamp has fallen. If a stamp is allowed to fall upon a single lump of ore resting upon the die it will be found that the upper portion of the lump will have been merely fractured, while a considerable proportion of the lump adjacent to the die will have been reduced to powder. The force of the blow has developed spherical waves in the ore particle, which traverse it until they meet with resistance from the die. They are then reflected backward, meeting succeeding on-coming waves, the result of which is to overcome the cohesion of the mass, comminuting the lower portion of the lump. Further experimentation will be necessary to determine the other conditions under which crushing is accomplished in the stamp-mill, but the statement I have made has, at least, been demonstrated by careful tests in the laboratory of the School of Mining. So far as it goes it leads to two conclusions regarding crushing for high capacity, viz., the feed should be kept thin, and the crushed material should be hurried out of the mortar as rapidly as possible. This is only affirming on theoretic grounds what has long been practically recognized and applied in California, and in other places where high amalgamating capacity and high crushing capacity were compatible. Nevertheless, there is a tendency even in California to overfeed the battery in a desire to put through a large amount of ore, and I think that this error on the part of millmen is too general everywhere. To be sure, it is an economic question, to be determined independently in every

mill, but it is very easy to err on the side of high capacity at the cost of reduced inside amalgamation. Mr. Dana Harmon, in a very suggestive paper on the Stamp Milling of Free Gold Ores, read before the Technical Society of the Pacific Coast (Sept. 7, 1900), affirms that if the ore is one that will yield its values in amalgamation, at least 60 per cent. of the gold should be caught in the mortar. This would not be altogether an unsafe rule for the millman, though I should modify it so far as to claim that 60 per cent. of the amalgamable gold should not be allowed to escape through the screen.

I have observed a marked tendency to discard inside copper plates in the West, and many of the best superintendents no longer attempt to use plates on the chuck blocks. When a low discharge is used the scour is undoubtedly excessive, and any amalgam that may have formed on them is necessarily washed out with the pulp, which is difficult to save. Fine particles of amalgam will escape from the ordinary mercury traps, and while outside plates will catch fine gold they accomplish very little, if anything, in arresting amalgam that may have issued from the mortar. I have used with success in narrow mortars, back plates with protecting cast iron shields so placed as to leave a space about one-eighth of an inch wide between the copper plate and the shield on the upper edge, and one-quarter of an inch wide on the lower edge. The pulp washes up between the two plates and over the shield, and on the return flow a portion of that which washed over the shield also passes between the shield and the copper plate. Amalgamation is thus facilitated, and scour is prevented. In setting back plates, they should always be placed so that the upper edge of the plate is higher than the normal rise of the pulp wave, and my experience has been that the greater amount of amalgam will be found in a band approximately coinciding with the upper limit of the rise of the wave. It is merely a question of time of contact, admitting of union between the gold and the mercury. For the same reason I prefer multiple apron plates, each plate not more than 2 ft. long, and successively overlapping each other, so that the pulp in falling from one to the other may have a better opportunity for prolonged contact with the mercury under each recess thus formed. Time is all impor-

tant in amalgamation, and many millmen do not provide the proper conditions in this respect for maximum extraction of the gold. A very common fault is that of using too much water, so that the pulp is swept too rapidly over the apron plates. As thin a stream of pulp should be obtained as will flow smoothly and freely over the plate, maintaining the crescent wave which is one of the indications of proper distribution of the pulp. Every effort should be made to save the gold by amalgamation, and no reliance should be placed upon the concentrators for this purpose. If any amalgamable gold large enough to be caught in the mortars and on the plates is saved on the concentrators, it is a sure indication that the milling conditions need modification.

I wish to insist upon the importance of a careful study of the pulp, which should be made with every ore, and at intervals of a few months with the same ore, unless the tailings assays show that the best possible results are being constantly obtained. For this purpose, after a "clean-up," before adding any mercury, ore should be crushed in one battery until normal conditions are established, taking care to feed a good average of the regular ore milled, and then the whole pulp stream should be saved until several barrels are filled. Allow this sample to settle, siphon off the clear water, and dry the residue. Weigh, and screen through a series of sieves beginning with a size slightly larger than that of the rated size of mesh in the battery screen, and carried down as fine as No. 150 mesh, or even to No. 200 mesh. Weigh these several products and calculate to percentages for plotting a sizing curve, which will show graphically just what quality of crushing your mill is doing. Divide each one of these products into two portions, mixing as for sampling and combining opposite quarters, and assay one of these portions corresponding to each size of screen mesh. The other portions should be tested as to the amount of amalgamable gold they contain by pan amalgamation, and the residues then concentrated on a vanning plaque. After assaying all products the results can also be plotted for convenience. when, if the experimenter were careful, the whole story should appear. Comparative tests or this sort, made upon pulp obtained after varying the milling

conditions, will readily show the way to secure the most perfect work possible in both amalgamation and concentration. In no other way may one so speedily and surely determine what adjustments to make as regards height of drop and discharge, size of screen, and quantity of water needed, and an effort to reach the same end by merely varying the milling conditions and assaying the tailings will take a longer time, involve losses that need not have occurred, and finally yield only an appoximation to the accuracy which may be reached by such a searching investigation as that outlined above.

The question of fine breaking of the ore before feeding to the stamp mill has received so much attention in late years that some mention must be made of this innovation. Like most good things, it has been abused by unthinking men, whose aim has been to cheaply crush a large amount of ore. When the gold in the ore exists in the free state, by which I mean that it is not locked mechanically or otherwise in the sulphides, and when the amount of coarse gold is large, there is no doubt that the results are highly economical. Since the stamp mill is not an economical crusher, the less work of this sort that we exact of it, while securing the best possible results in amalgamation, the better. Furthermore, the coarser the material fed the less duty is the mill performing, and also the splash is affected to some extent, which has a direct influence upon amalgamation. The main question is that of time for complete amalgamation. The finer the ore fed the more rapidly will it pass through the mortar. This may be corrected by increasing the height of discharge, or by using roomier mortars. The economic gain in crushing is then lost, however, and the only benefit, if there be any, is to be looked for in superior amalgamation due to more prolonged retention of ore in a finer state of sub-division in the mortar.

The weight and speed of stamps is a point regarding which there is little agreement in opinions. So far as crushing efficiency is concerned there is little difference between the two, within the limits of weights which may be regarded as standard today, viz , 850 lbs. and 1100 lbs.; that is to say, the difference in speed bringing the output per horse-power expended to practically the same point. So far as

I have observed the choice depends upon the character of the ore, the lighter stamp producing enough less violent splash to facilitate the amalgamation in the mortar of more fine gold, when the height of discharge in the two cases remains the same. A very slight modification in the height of discharge, however, will give to the heavier stamp the same advantage. Any material difference between light and heavy stamps is to be looked for in the wear and tear of the mill, the abrasion of shoes and dies per unit of ore crushed, and the relative weights of metal thrown on the scrap heap in the form of worn out shoes and dies. On this important point I have no certain data on which to base conclusions. The experience of millmen with regard to this would be of great value.

I wish to commend Mr. Harmon for his protest against the use of potassium cyanide solution for brushing and brightening the plates. Prudently used it may do no harm, but I have known many mills in which important losses of amalgam undoubtedly occurred from the too frequent application of this chemical. A solution of caustic soda, or lye from the leaching of wood ashes, will cleanse plates perfectly; they are not solvents for gold, and incidentally they are free from the poisonous quality of KCN.

In this brief, sketchy paper, I have not attempted to do more than throw out a few suggestions on important points, merely as a basis for discussion, without any pretence of adding new knowledge, and certainly I shall not attempt to lay down any rules concerning the duty of stamp mills. This matter is relative, dependent upon so many varying circumstances, that the only guide for the millman is to study his pulp often and critically, so that he may know, and not guess, when he has obtained the combination of highest crushing capacity with the highest amalgamable capacity, adjusted to the line of the highest economical results. It is not easy to do this, not nearly so easy as most men may think, and a man must possess the peculiar qualities of the experimenter—in other words he must know something of scientific methods of analysis—in order to be sure that he has attained the result at which he is aiming.

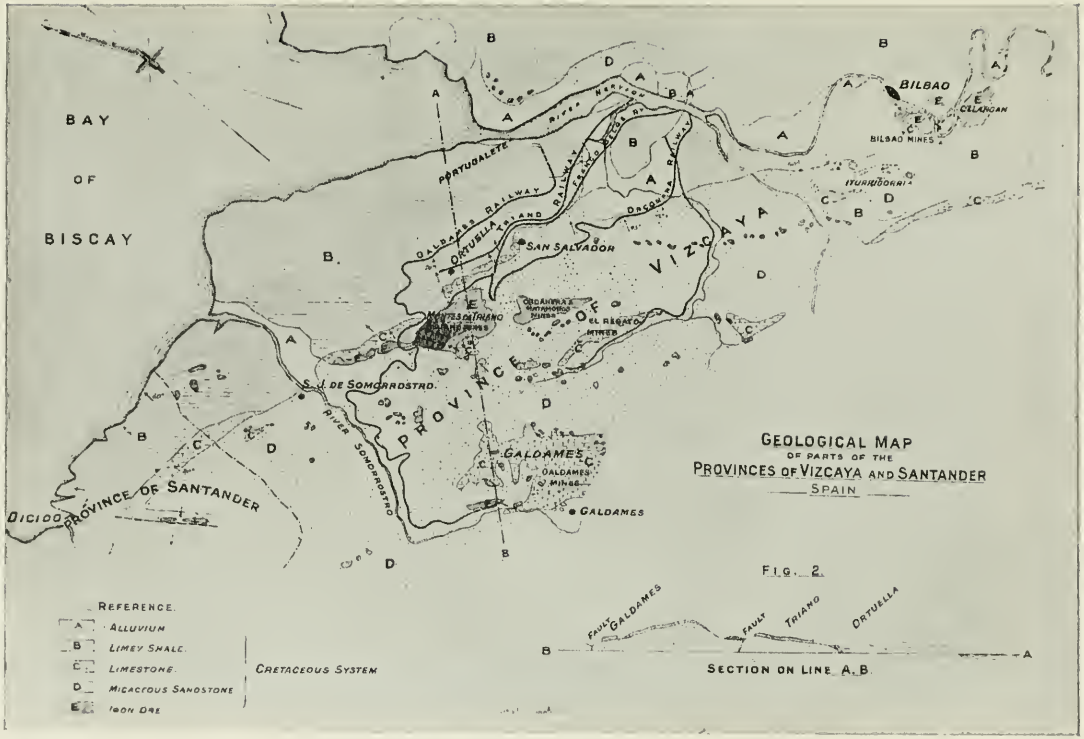
Notes on the Iron Ore Deposits of Bilbao, Northern Spain.

By Frank D. Adams, M.Sc., Ph. D., F.G.S.

The Iberian peninsula, while producing comparatively little iron, is known to contain many large deposits of iron ore some of which have been worked from very early times. Iron ore occurs throughout the whole length of the Cantabrian Mountains on the northern coast of Spain, in Navarre, through the Basque Provinces, Santander and Asturias to Northern Portugal. Other large deposits are known in eastern and southern Spain, in the Provinces of Murcia, Almeria, Seville and Malaga. It has however, owing to difficulties of transport, been worked only near the coast, but many great ore bodies which exist inland—in Leon, Old Castile, Aragon, Andalusia and Murcia—are now being opened up. †

The most important deposits, or at least those which up to the present time have been worked far more extensively than any others, are those which are situated in the district of Vizcaya, in the Basque Provinces, and which, lying near Bilbao from which point the output is shipped, are known as the Bilbao Iron Deposits. These deposits are situated on the northern slope of the Cantabrian Mountains. The ground is for the most part hilly or mountainous, with very little flat land even along the sea shore. The ore lies chiefly at altitudes of between 600 and 1,100 feet. The most important of these Bilbao Iron Ores are those of Somorrostro and Orcanera, the former of which has been worked continuously for several hundred years, and it is believed that it is these deposits which are referred to by the Elder Pliny in the first century of our era when, in his Natural History, he says: "In the part of the Cantabrian coast which is washed by the ocean, there rises a high and steep mountain, which marvellous to relate is composed entirely of iron."

† Zeit. für. Prak. Geol., Nov., 1900.



GEOLOGICAL MAP
OF PARTS OF THE
PROVINCES OF VIZCAYA AND SANTANDER
SPAIN

ESPERANZA MINE.

Shows general character of the surface of the district and open cut from which Campanil is obtained.

It was from these ores that the metal for the celebrated Toledo blades was obtained, and in fact in the time of Shakespeare these deposits were so renowned that the term *Bilbo* was employed to designate various objects of iron and steel, as sword blades, fetters, etc., and so we find Falstaff (in the *Merry Wives of Windsor*) speaking of himself as "compassed like a good bilbo in the circumference of a peck," and in *Hamlet* a situation described as "worse than the mutines in the bilboes."

These Bilbao deposits however were first worked on a very large scale when the great demand for ores of this particular class was created by the introduction of the Bessemer process, and there are now (1899) in the Bilbao District, no less than 204 iron mines. The following figures will show the rapid increase in the production of iron ore in the District of Vizcaya:—

1861	54,000 tons.
1870	268,500 "
1880	2,345,000 "
1890	4,272,918 "
1899	6,146,542 "

Almost the entire amount in 1899 was exported, only 621,165 tons, or 6.7 p.c. of the total amount mined, being smelted in Spain. The ore is shipped chiefly to England, although a considerable amount is sent also to Germany. In 1899 the shipments to Great Britain, Germany and the United States of America were as follows:—

Great Britain	3,955,000 tons.
Germany	550,000 "
United States of America	75,000 "

The small shipments to the United States are owing to great fluctuations in freight rates between Spain and North America. It is important to note that 87½ p.c. of the iron ore imported into Great Britain comes from Spain and chiefly from these Bilbao deposits.

Bilbao, which is the chief port of north-eastern Spain, is situated on the River Nervion, 6 miles from the sea; the name Bilbao being derived from the Basque word *Bulibao*, which means "Town on the Plain." In addition to being an excellent port it has abundant rail-

way communication with the surrounding country. The river all the way down from Bilbao to the sea presents a busy scene, being filled with ships flying the flags of all nations, loading iron ore and other products at the almost continuous succession of wharves and landing stages which occupy the bank of the river. The bulk of the Bilbao ore as shown in the accompanying map is in the Somorrostro District, about Triano and Orcanera, some 6 or 7 miles west of the city of Bilbao on a high ridge immediately south of the railway. It is reached by taking the train to Ortuella from which place good roads lead to the mines. Great ore dumps are seen by the side of the railway all along the base of the Somorrostro ridge, the ore being carried down from the mines by all sorts of conveyances, from the picturesque but slow moving Basque cart drawn by a pair of oxen, (See Plate 6), to great systems of overhead wire rope tramways of modern construction.

The most extensive occurrence (Triano, Ventura, etc.) is irregular in shape, about two miles long and at Mt. Triano five-eighths of a mile wide, with a maximum thickness according to Kendall § of 220 feet.

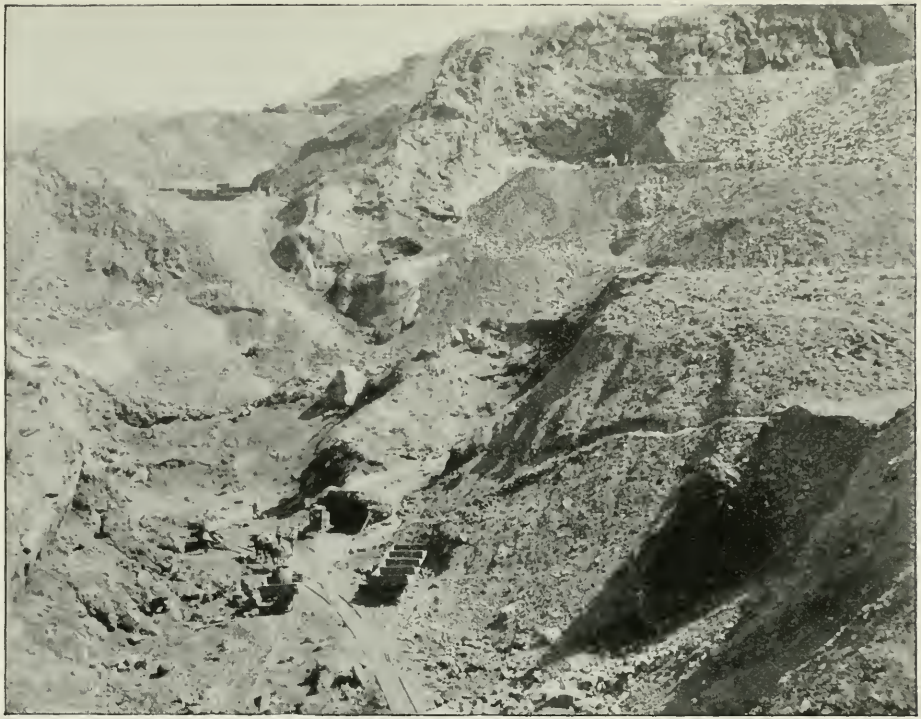
The country rock is here Upper Cretaceous in age and has the form of a saddle, corresponding in direction with the shore, and the ore deposits are found on both sides of this. The Cretaceous shows the following succession in descending order :—

1. Light grey shale, very calcareous.
2. Grey limestone, (about 250 feet thick).
3. Dark micaceous sandstone, calcareous.

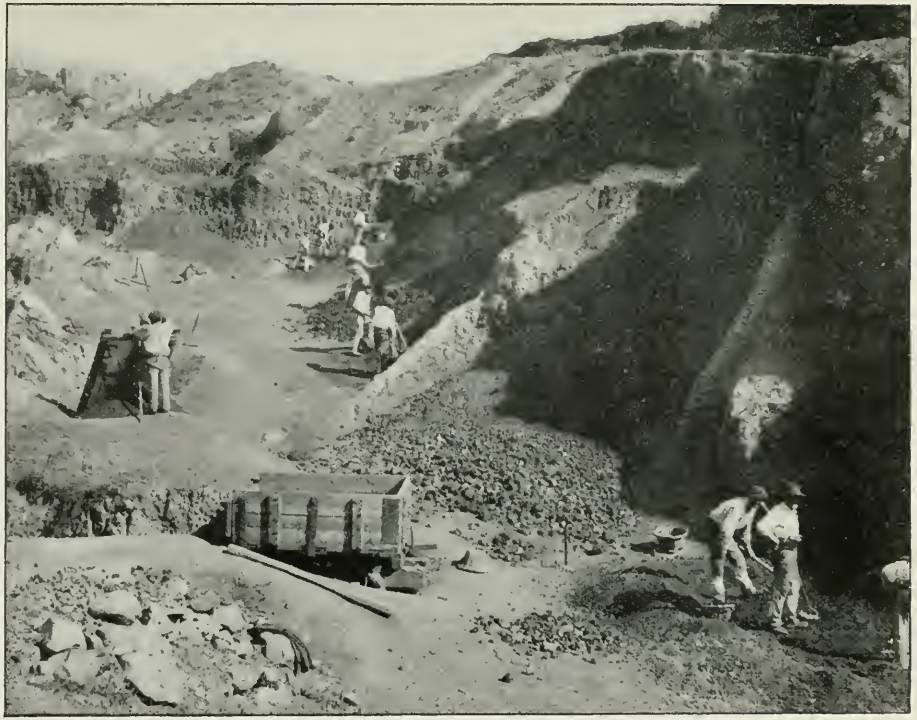
The strata where the bulk of the iron deposits occur have a general northeast dip which shows however many variations and disturbances. Their present attitude is the result of the upheaval of the Cantabrian Mountains in Tertiary times.

The ore occurs exclusively in connection with the limestone and is thus limited in depth at any point by the lower surface of that rock. This is very important, showing, as it does, that the deposits are

§ The Iron Ores of Spain. Trans. of the Fed. Inst. Mining Eng. Vol. III, 1891-92, p. 607.



Workings near the Esperanza Mine.
Afford Campanil.



"CHIRTA"

Residual mantle of ferruginous clay with nodules of limonite scattered through it. The underlying limestone is seen protruding through the "Chirta," in the background. The method of working the deposit and preparing the limonite for shipment is also shown.

essentially superficial in character and extent. The erroneous notion that in the case of the Bilbao deposits we have to do with "mountains of ore," arises mainly from the fact that the slopes of the hills coincide in some places with the dip of the limestone, and this rock having been replaced by ore, the whole hill or mountain seems to the casual observer to be a mass of iron ore, while, as a matter of fact, the ore is present merely as a superficial crust or coating.

The various ore bodies have an irregular elongated form, their longer axes coinciding with one another and with the strike of the strata. The relations of the sandstone, limestone and shale to one another and to the iron ore are well seen in accompanying sections. In one of the Triano sections (Figure 1) the overlying covering of shale is still preserved at the northern end. The other Triano section (Figure 2) shows the limestone entirely removed and replaced by ore in the flat portion of the area about the Concha and Adela Mines, the ore resting directly upon the underlying sandstones. In almost every part of the area the ore appears with a denuded surface, and is either actually exposed to view or concealed by a thin superficial covering. Where the limestone has been completely removed it lies directly on the surface of the sandstone. The ore deposits being thus essentially superficial in character, there are no *mines*, properly speaking, in the Bilbao District.

The ores are of five classes, and are designated locally as follows:—

1. *Vena.*—Red Hematite; compact, soft or sometimes powdery. Generally the purest of the ores, holding about 64 p.c. of iron. It was the only ore used in former times to supply the Catalan forges. Very little of it now remains.

2. *Campanil.*—Red Hematite; compact and crystalline, with numerous little drusy cavities lined with calcite. Said to derive its name from the ringing or bell-like sound which it gives out when struck with a hammer. It is the best of the ores, with the exception of *Vena*, and is one of the chief ores in the Triano Mines. It strongly resembles the hematites of Whitehaven and Furness. It may be said to carry about 55 to 58 p.c. of iron with 4 to 8 p.c. of lime.

3. *Rubio.*—Limonite, carrying about 55 p.c. of iron, but usually more or less siliceous.

4. *Chirta.*—A ferruginous clay, with limonite nodules scattered thickly through it.

5. *Carbonato.*—Siderite, carrying about 44 p.c. of iron. Found almost exclusively at or near the base of the hematite or limonite deposits, and can be seen to pass into them. It was undoubtedly the primary ore and has by its alteration given rise to the *Vena*, *Campanil* and *Rubio.*

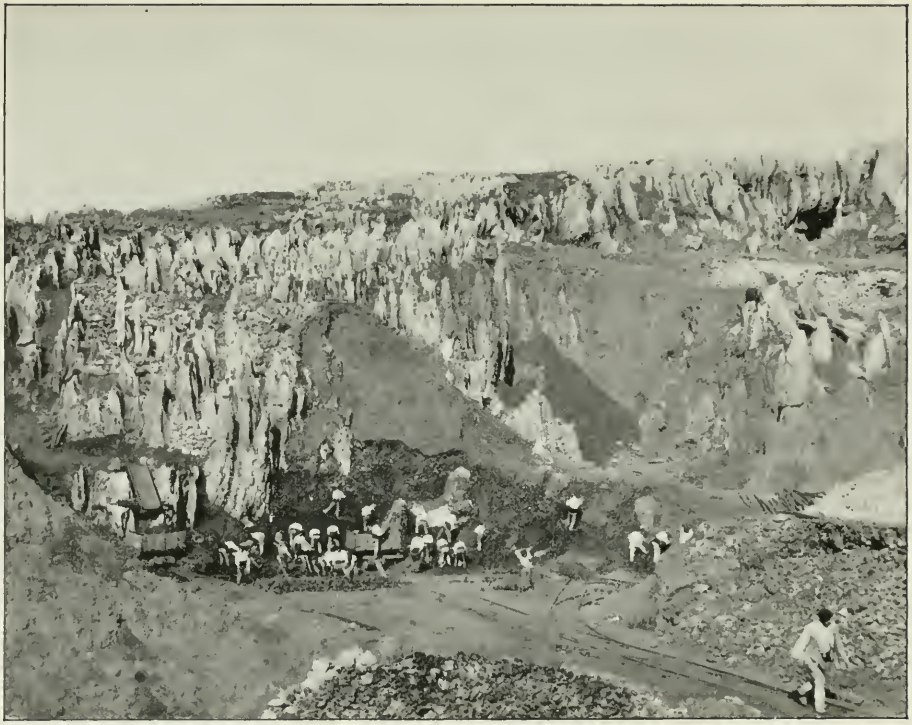
These ores are all very low in phosphorus. The Carbonato often contains a small amount of sulphur, but as it is roasted before exportation, this impurity is for the most part driven off.

The following are analyses of samples of the several varieties:—

	Vena.	Campanil	Rubio.	Carbonato
Ferric oxide	90.70	84.00	79.96	5.31
Ferrous oxide	....	....	....	50.18
Manganous oxide	1.30	1.90	.70	1.00
Alumina	.15	....	1.44	
Lime	1.00	4.60	1.00	.87
Magnesia	.02	....	.55	3.21
Silica	1.05	3.20	8.10	3.60
Carbonic acid				
Sulphuric acid	....	....	.10	....
Sulphur	.03	....	....	trace
Phosphoric acid	....	trace	.03	
Water and carbonic acid	5.40	6.00	....	36.28
Water	....	....	8.25	
	99.65	99.70	100.13	100.45
Metallic iron	63.49	58.80	54.62	43.96

The workings are practically all open cuts with a few short tunnels. The accompanying photographs* show some of the principal occurrences in the Triano District. The first of these (Plate 1) shows

* For those photographs I am indebted to Professor Ries of Cornell University, in whose company I had the pleasure last summer of visiting the deposits described in the present paper.



"CHIRTA."

Showing the peculiar pinnacled surface of the underlying limestone. The material is being shovelled into ox carts, in order that it may be taken to the mill to be washed.

the Esperanza "mine." An open cut in Campanil mixed with streaks of yellow ferruginous clay and limonite. The ore contains the little drusy cavities lined with calcite, mentioned in describing the ore, in great abundance, one or more being present in every hand specimen.

Another similar occurrence of Campanil, worked by a great open cut and tunnels, near the Esperanza, is shown in Plate 2.

The next workings which were visited presented a deposit of a different character, the so-called Chirta. It is a yellow ferruginous clay with nodules of limonite scattered abundantly through it. It lay upon the limestone, mantling it deeply, the bed rock however protruding in places, as seen in the background of the picture. The face of the clay bank was being torn down by workmen with picks, the material being then thoroughly disintegrated by means of implements resembling forked mattocks, and then screened. The several processes are shown in the photograph (Plate 3). In this way the limonite nodules are separated from the clay and the ore prepared for shipment.

In other workings near by, the limonite-bearing clay was mixed with water and passed through an inclined revolving cylinder, the inner surface of which was studded with spikes. As the material passed out of the lower end of the cylinder and down a gently inclined shallow trough, any large unbroken clay masses were picked out by a number of men and boys, and were thrown aside to be crushed and once more passed through the cylinder. The finer washed stuff consisted of the limonite nodules and the water carried away the clay. A rather clumsy process, entailing much labour, the wages of a man, however, being only two pesedas a day.

The origin of this Chirta is well seen in some or the neighbouring occurrences. (Plate 4). The underlying limestone where it is exposed on the higher ground or where it is laid bare by the removal of the Chirta by the pick of the workman, is seen to have undergone superficial solution giving rise to that peculiar surface form, often seen in the bare limestone districts of the Upper Alps and known as Karren structure. The edges of the limestone beds stand up like sharply pointed slabs, a form

evidently produced by the solvent action of the rain or percolating waters upon the surface of the limestone, while the Chirta representing the insoluble residue, which has gradually accumulated from the solution of a very considerable body of limestone, remains as a mantle upon the surface of solution and in pockets between the Karren. Much of the iron oxide has gathered itself together by concretionary processes into the limonite nodules which constitute the ore.

In another immense open cut or quarry, worked in benches and known as the San Benito property, the Rubio and Carbonato were found. A photograph of this is shown in Plate 5. The Carbonato or Siderite has a banded appearance and seems, in places at least, to be interbedded with the limestone. It is seen only in the lower levels of the cut, being covered by the porous limonite known as Rubio, which is the superficial alteration product of the Carbonato and can be observed to pass into it, working downward along joint planes and fissures in the siderite and often enclosing blocks of the latter not yet entirely altered. At the time of our visit, the white Carbonato and dark Rubio were being worked together along a face in the cutting where they occurred intimately associated, one passing into the other.

The Carbonato is calcined before being shipped, in furnaces situated on the lower slopes of the cut.

The origin of the ores seems to be as follows :—

The limestones themselves and especially the overlying calcareous shales, contained as these rocks so frequently do, a certain amount of iron disseminated through them in the form of various ferruginous compounds. The country during later Tertiary and Quaternary times was subjected to long continued denudation. The calcareous strata under these circumstances were dissolved and the iron passing downward in solution was, in the lower portion of the limestones, converted into carbonate of iron, which may therefore be considered as the primary ore, being the first ore concentrated in bodies of considerable size.

As the denudation proceeded, the calcareous shales and the lime stones, being thoroughly leached out, left their insoluble residues as a

SAN BENITO PROPERTY.

Yields Rubio and Carbonato.

mantle of residual clay, and under the oxydizing influence of the air and oxygenated waters, much of the iron instead of being removed by the waters was left behind in the form of insoluble oxides,—Limonite or Hematite, "Chirta" or "Campanil"—mixed with ferruginous clays. As the surface of the country became lowered, the deeper bodies of Carbonato also became oxidized to Rubio—and the deposits assumed their present form. The concentration is undoubtedly going forward at the present time.

Farther to the east along the same line of folding, in the Pyrenees, as for instance at the well known Rancie Mines near Vicdessos, there are also iron ore deposits in the form of bedded veins of limonite, occurring in limestone and passing over in depth into siderite. The strata however here being highly tilted, the deposits follow the limestones down to great depths and are not confined to the surface as in the case of the Bilbao ores.

The Bilbao ores in their relations and mode of occurrence bear a strong resemblance to the limonite deposits of the great limestone valleys of central and eastern Pennsylvania, which have been worked for the production of iron ever since the rise of this industry in America. These have been made the subject of a recent paper by Mr. T. C. Hopkins,† who shows that they occur chiefly in the residual clays formed by the solution or disintegration of the Ordovician and Cambrian limestones and slates underlying these portions of Pennsylvania, the original source of the iron being the strata by whose decay the clays in question were formed, and through which strata it was originally disseminated chiefly in the form of carbonate.

It is stated that the Bilbao ores are steadily degenerating in quality,‡ and also that the deposits are rapidly approaching exhaustion. Lying altogether in the limestones and being thus essentially superficial deposits, exposed and worked over the whole surface

† Cambro-Silurian Limonite Ores of Pennsylvania. Bull. of the Geol. Soc. of America, vol. 11, 1900.

‡ See Paper by Kayser, in Stahl and Eisen, vol. xviii, p. 373.

simultaneously, it would seem that they have seen their best days. "We are continually hearing that the deposits are almost exhausted," said a Spanish ore shipper, "but year by year we have a larger output." This very fact, however, is hastening on the end. But while these deposits may be and probably are approaching exhaustion, many new deposits, as has been mentioned, are being opened up farther inland, so that the supply of Spanish ore will probably continue without serious diminution for at least some years to come.

SCENE ON ROAD BETWEEN ORTUELLA AND TRIANO.

Basque ox cart employed to carry ore.

Notes on Crushing and Sizing in the Ore-Dressing Laboratories of McGill University.

By Dr. J. Bonsall Porter, Montreal.

As a preliminary to all or almost all separating or metallurgical processes, the ore is passed through machines for the purpose of reducing the large sized lumps, in which form it generally comes to the mill, to smaller pieces or to grains of various sizes according as may be required in the subsequent operations of preparing it for the market. In many cases, such as the preparation of coal, this crushing and sizing is almost all that is necessary, while in free gold milling the breaking of the gold-containing ore in order to prepare it for the stamps, and also in its passage through them, constitutes the greater part of the operation, setting free the gold and leaving it to the mercury to reap the profits of the labor.

For these and other reasons the simple process of ore crushing is as important, if not more important, than the various other processes in the ore's progress from the mine to the mint or smelter.

The choice of a rock-breaker or ore-crusher for any special purpose, depends chiefly upon its capacity, the amount of power it consumes per ton of ore crushed, and the percentage of fines it makes. In this paper I have only been able to treat of the last of these conditions, owing to various reasons.

The crushing devices used in these tests were chosen for their variety, and they nearly all are good representatives of their respective class of crusher. They include a comet crusher size A; a Dodge crusher 12 inches by 9 inches; a Huntington mill 3½ feet in diameter; a set of crushing rolls 16 inches in diameter, and 10 inches face; all these manufactured by Fraser and Chalmers: Gale's standard sample grinder; a ball-mill designed especially for laboratory purposes by Dr. Porter, and built by the Novelty Iron Works, Montreal, (the action of this mill is practically the same as those in common use; and lastly a five stamp battery.

Ores of various crushing qualities and economic importance such as magnetite, calcite containing galena blende, etc., pyrrhotite from several localities, several lots of gold quartz, coal, common limestone, etc., were run through some or all of these appliances, the resulting products analysed by means of sieves, and the results tabulated.

The tables are divided into two parts. The first two columns give the percentage of coarse stuff and fine stuff from the operation (fines being taken as all below 14 mesh) and the remaining columns being a further analysis of the fines.

At the head of each column the common name of the sieve is given, 15 mesh, 30 mesh, etc. The actual clear opening between the wires, however, was determined by counting the number of wires per inch (which often varied considerably from the specifications in the trade catalogues), and measuring their diameters by means of a micrometer. The table below gives the openings thus determined; the third column gives the average size of grains coming between the two bracketed sieves, and is used in the tracing of the curves which accompany the ore and crusher tables.

Name of Sieve.	Clear opening in inches.	Average size of grains in ins.
14 mesh	.0464	
18 "	.0005	.0385
24 "	.0235	.0270
40 "	.0153	.0194
60 "	.0119	.0136
70 "	.0084	.0101
100 "	.0062	.0073
150 "	.0043	.0052
200 "	.0026	.0034

Most of the operations are tabulated twice, first in the table devoted to a special machine, and then in those which show the effects of different machines on the same ore. In order to make these last more interesting and as valuable as possible I kept the condition of the various crushers approximately constant all through.

In the crushing by means of the ball-mill, the amount of fines depend upon the time the crusher is in operation, the amount of ore inside, and the number and weight of the balls. The last two of these conditions were kept uniform during the test, therefore the effects of the first, time, is shown by the first two columns of the table devoted to this style of grinder, and the curve which accompanies it. The further analysis of these fines show practically the same result after the first hour or so.

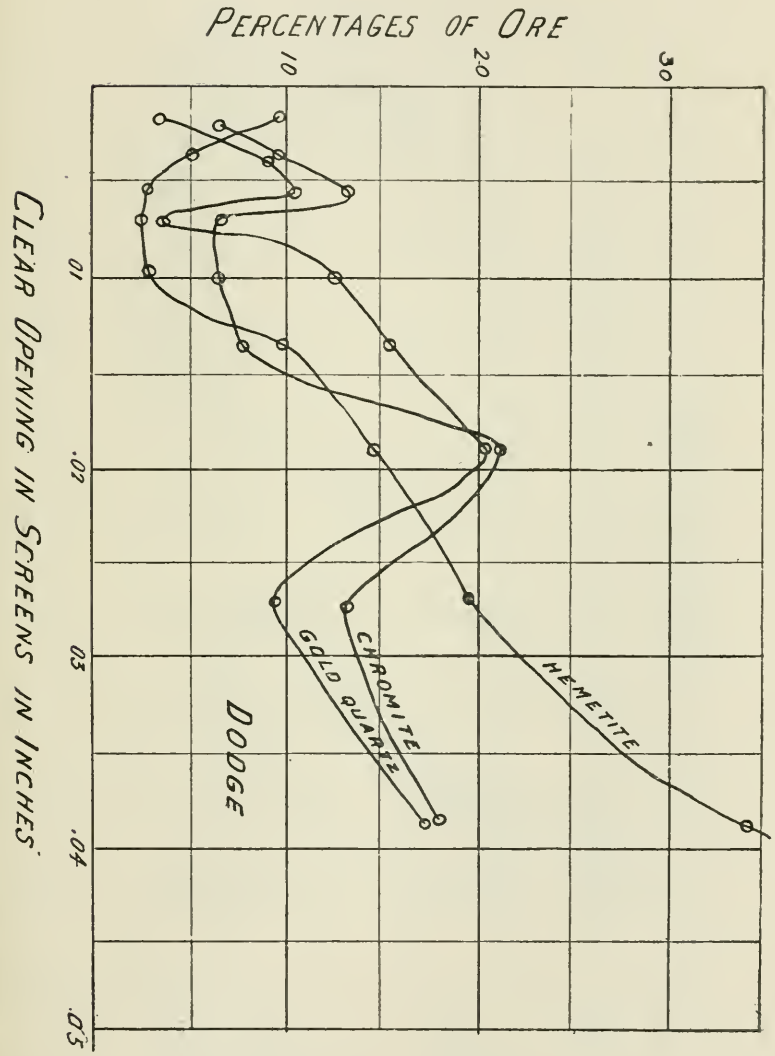
The curves as can be seen at once, are not meant for interpolation between the points marked with a circle, but simply show in a graphical form the difference between the effects of the different ore or crusher at these points.

It was my intention to check the results of some of the sieving directly by means of an especially constructed micrometer, but time would not allow.

I.—Dodge. Set at ½ inch.

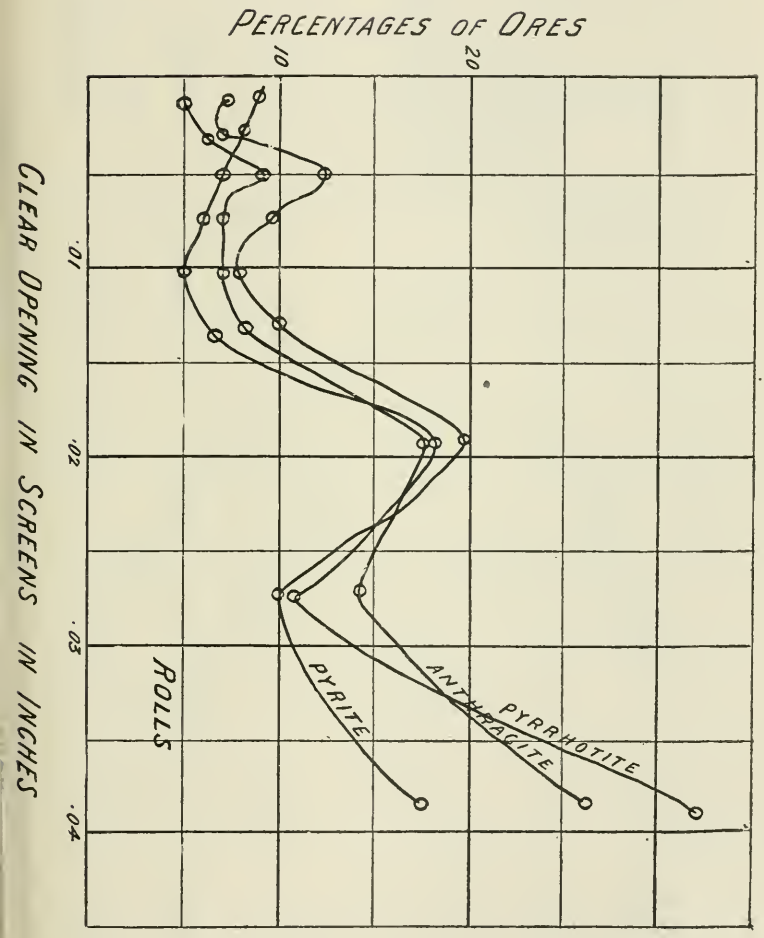
Name of Ore.	Over 14.	Under 14.	14–18.	18–24.	24–40.	40–60.	60–70.	70–100.	100–150.	150–200.	Under 200.	Remarks.
Hemetite	97·95	2·05	34·0	19·5	14·5	9·7	2·5	2·5	2·5	5·0	9·8	
Pyrrhotite	77·3	22·7	27·2	13·1	31·8	6·6	4·8	5·3	4·8	3·2	3·2	From Sudbury Dist.
Chromite (*a*)	72·7	27·3	16·2	11·2	11·3	10·1	5·5	8·0	28·2	5·5	4·0	In Serpentine, from Eastern Townships.
Chromite (*b*)	79·8	20·2	17·2	11·2	19·2	8·4	6·4	8·9	18·9	5·9	3·8	
Chromite (*c*)	83·5	16·5	17·8	13·2	20·8	7·3	6·3	6·1	13·1	9·1	6·3	
Gold Quartz	78·4	21·6	17·1	9·3	20·4	15·2	12·3	2·8	10·3	9·3	3·3	With slate.
Pyrrhotite	73·0	27·0	14·0	9 0	12·5	6·5	6·0	6·5	14·5	16·0	15·0	From Rossland.
Arsenopyrite	85·0	15·0	17·0	6·0	11·0	7·0	8·0	8·0	11·0	12 0	20·0	Gold bearing Actinolite, Ont.
Bituminous Coal	82·0	18·0	25·0	14·0	18·0	8·0	8·0	5·0	7·0	7·0	8·0	Acadia Seam, Pictou County, N. S.
Limestone	74·8	25·2	15·9	12·1	21·8	*9·9	29·1	4·0	.....	7·2	.....	From Road.
Anthracite	94·83	5·17	36·1	19·2	23·2	*1·3	10·6	1·9	.....	7·7	.....	
Tin Stone	81·5	18·5	22·7	11·3	20·6	*0·5	22·7	5·9	.....	16·3	.....	Low grade, Dolcoath, Cornwall.
Quartz	87·2	12·8	21·8	14·8	21·2	*0·8	10·9	12·5	.....	18·0	.....	Gold bearing, Rat Portage.
Pyrite	85·5	14·5	12·4	8·4	22·2	*0·7	21·5	8·3	.....	26·5	.....	From Eustis, Que.
Calcite	73·8	26·2	16·8	13·8	23·0	*3·8	16·8	8·4	.....	17·4	.....	With Galena and Blende.

Figures at top of columns designate number of mesh per inch in sieve. *50-mesh sieve used.


PERCENTAGES OF ORE
10
20
30
.01
.02
.03
.04
.05
CLEAR OPENING IN SCREENS IN INCHES.
DODGE
GOLD QUARTZ
CHROMITE
HEMETITE

II.—Rolls. Set touching.

Name of Ore.	Over 14.	Under 14.	14–18.	18–24.	24–40.	40–60.	60–70.	70–100.	100–150.	150–200.	200–0.	Remarks.
Hematite	16.7	83.3	11.2	10.3	78.0	8.4	7.7	9.9	14.9	12.4	7.2	
Graphite	41.4	58.6	20.5	13.0	18.7	8.1	7.7	7.5	9.7	8.2	6.6	
Gold Quartz	35.8	64.2	21.8	11.3	17.4	6.4	5.7	5.6	20.6	6.5	4.7	Halifax County, N.S.
Anthracite	45.5	54.5	26.0	14.0	18.0	8.0	7.0	7.0	9.0	6.0	5.0	
Calcite	39.4	60.6	20.6	12.2	20.3	7.6	6.3	7.9	10.1	7.6	7.4	With Galena and Blende.
Quartz	37.8	62.2	25.0	25.0	16.4	8.8	10.5	5.3	5.6	1.9	1.5	Gold Bearing, Rat Portage.
Pyrites	27.7	72.3	17.2	9.9	19.6	9.9	7.5	9.6	12.5	6.3	7.5	From Eustis, Que.
Tin Stone	39.1	60.9	22.1	12.6	19.7	8.0	5.4	7.4	10.0	7.2	7.4	Dolcoath Mines, Cornwall, Eng.
Galena Blende	65.5	34.5	19.0	8.0	14.0	7.0	5.0	8.0	24.0	10.0	5.0	
Magnetite	20.0	80.0	15.0	11.0	20.0	8.0	8.0	9.0	12.0	10.0	7.0	Titaniferous.
Pyrrhotite	48.5	51.5	15.0	8.0	15.0	6.0	6.0	7.0	11.0	13.0	19.0	From Rossland.
Arsenic Pyrite	61.0	39.0	18.0	8.0	16.0	8.0	7.0	9.0	17.0	10.0	7.0	Actinolite, Ont.
Pyrrhotite	76.0	24.0	31.0	11.0	18.0	6.0	5.0	6.0	7.0	8.0	9.0	From Parry Sound.
Bituminus Coal	65.3	34.7	31.0	12.0	20.0	8 0	7.0	8.0	9.0	3.0	2.0	Nova Scotia.

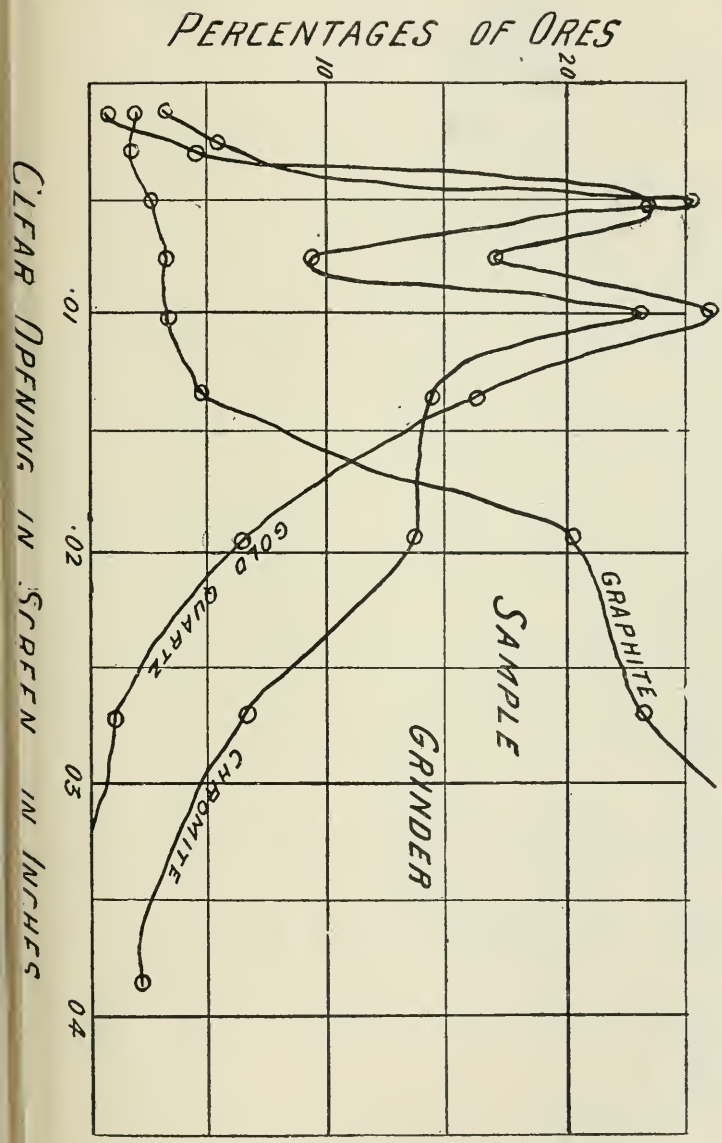

PERCENTAGES OF ORES
10
20
.01
.02
.03
.04
ROLLS
PYRITE
ANTHRACITE
PYRRHOTITE
CLEAR OPENING IN SCREENS IN INCHES

III.—Huntington.

Name of Ore.	18–24.	24–40.	40–60.	60–70.	70–100	100–150.	150–200.	200–0.	Remarks.
Chromite (A).....	Through 30-mesh	14.5	16.5	16.2	16.0	31.0	4.2	1.8	In Serpentine, from Province of Quebec.
Chromite (B).....		12.8	18.2	12.2	17.3	34.2	3.2	2.5	More time and water used than in (A).
Chromite (C).....		8.5	17.3	17.1	16.5	34.3	4.0	2.5	More time and water used than in (A) and (B).
Gold Quartz.....	Through 40-mesh ..	0.6	10.0	21.3	17.4	43.6	4.6	1.6	From Halifax County, N.S.

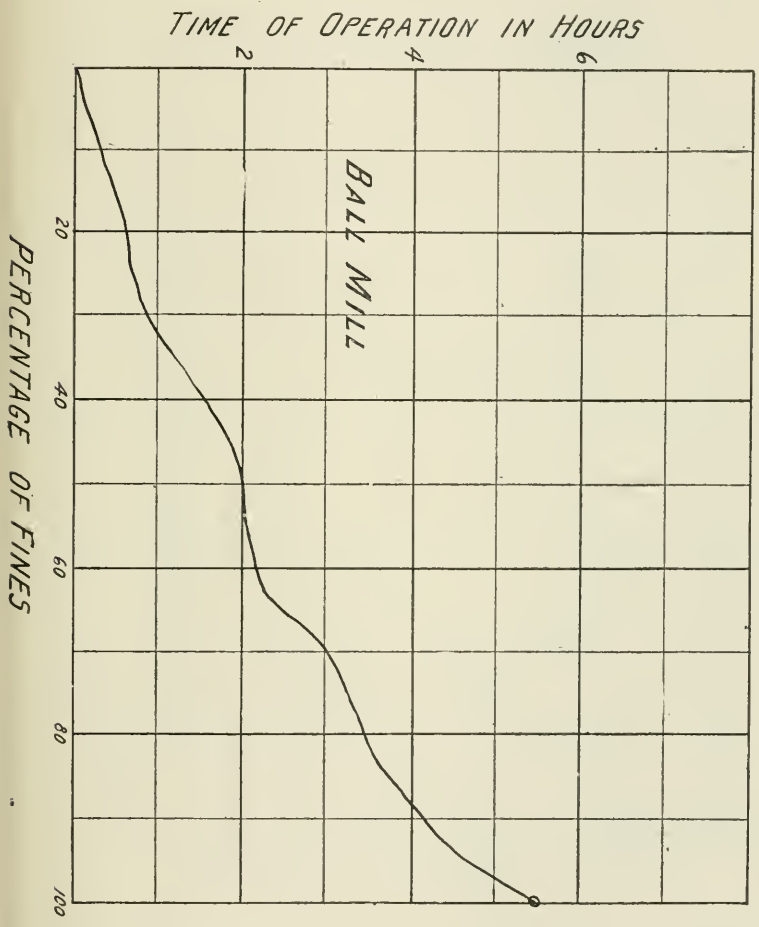
IV.—Sample Grinder.

Name of Ore.	Over 14.	Under 14.	14–18.	18–24.	24–40.	40–60.	60.70.	70–100	100–150.	150–200.	200–0.	Remarks.
Graphite.....	19.0	81.0	38.7	23.5	20.4	4.9	3.1	3.1	2.5	1.9	1.9	
Chromite (A).....	0.0	100.0	2.0	6.1	13.7	14.7	23.3	9.0	25.2	4.6	1.4	
Chromite (B).....	0.0	100.0	2.1	2.8	7.9	15.9	20.2	11.8	32.3	4.7	2.3	
Chromite (C).....	0.0	100.0	.....	.....	3.0	8.0	13.2	17.8	47.0	8.0	3.0	All through 30-mesh.
Gold Quartz.....	0.0	100.0	.....	0.6	6.3	16.1	26.0	16.9	24.4	5.3	3.4	From N.S.


PERCENTAGES OF ORES
10
20
.01
.02
.03
.04
CLEAR OPENING IN SCREEN IN INCHES
GOLD QUARTZ
CHROMITE
SAMPLE
GRINDER
GRAPHITE

V.—Ball Mill.

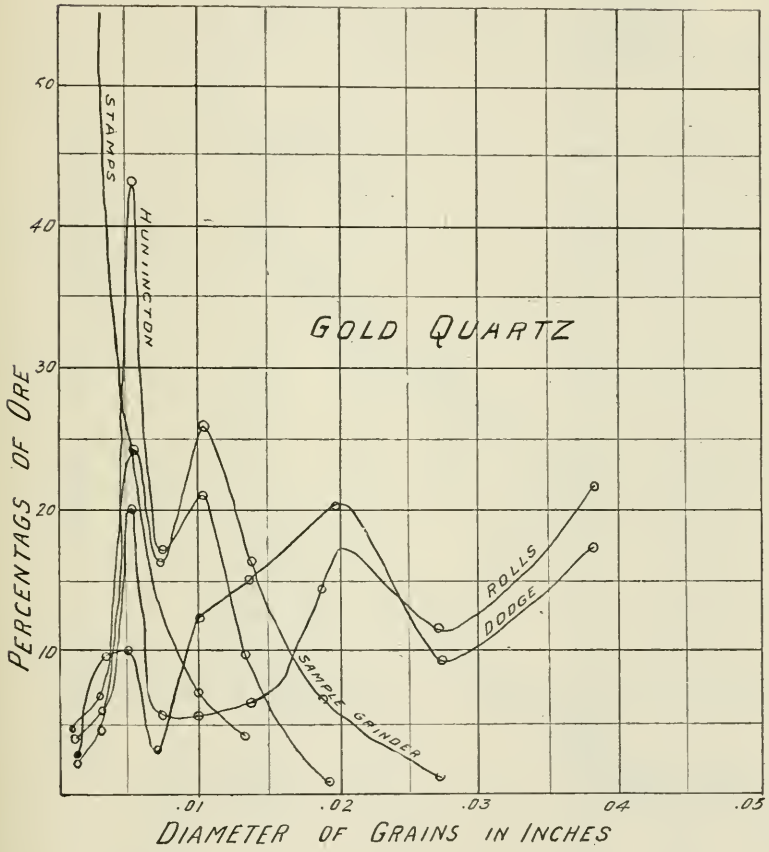
Time of Operation.	Over 14.	Under 14.	14–18.	18–24.	24–40.	40–60.	60–70.	70–100.	100–150.	150–200.	200–0.	Remarks.
½ hour	85·0	15·0	16·0	8·0	14·0	6·0	4·0	5·0	10·0	10·0	27·0	Low grade Tin Stone from Dolcoath Mine, Cornwall, Eng., used in this determination.
1 "	68·0	32·0	13·0	6·0	14·0	8·0	6·0	5·0	8·0	12·0	28·0	
1½ hours	62·0	38·0	11·0	7·0	12·0	7·0	6·0	7·0	7·0	9·0	34·0	
2 "	52·0	48·0	8·0	5·0	12·0	8·0	6·0	9·0	10·0	8·0	34·0	
2½ "	35·0	65·0	5·0	4·0	12·0	8·0	7·0	7·0	7·0	12·0	38·0	
3 "	31·0	69·0	3·0	3·0	10·0	7·0	9·0	10·0	11·0	7·0	40·0	
3½ "	21·0	79·0	3·0	3·0	9·0	9·0	11·0	10·0	10·0	5·0	40·0	
4 "	12·0	88·0	3·0	2·0	7·0	8·0	10·0	10·0	12·0	8·0	40·0	
4½ "	7·0	93·0	2·0	2·0	5·0	6·0	9·0	11·0	13·0	12·0	40·0	
5 "	3·0	97·0	1·0	1·0	3·0	3·0	6·0	11·0	17·0	18·0	40·0	
5½ "	0·3	99·7	0·5	0·5	1·0	2·0	6·0	12·0	18·0	20·0	40·0	


TIME OF OPERATION IN HOURS
2
4
6
BALL MILL
PERCENTAGE OF FINES
20
40
60
80
100

VI.—Gold Quartz from Halifax County, Nova Scotia.

Name of Crusher.	Over 14	Under 14	14–18.	18–24.	24–40.	40–60.	60–70.	70–100.	100–150	150–200.	200–0.	Remarks.
Dodge	78.40	21.6	17.1	9.3	20.4	15.2	12.3	2.8	10.3	9.3	3.3	Set at ½ inch.
Rolls	35.8	64.2	21.8	11.3	17.4	6.4	5.7	5.6	20.6	6.5	4.7	Rolls touching.
Huntington	0.0	100.0	.....	.....	0.6	10.0	21.3	17.4	43.6	4.6	2.5	Through 40 mesh.
Sample Grinder	0.0	100.0	.....	0.6	6.3	16.1	26.0	16.9	24.4	5.3	4.4	
Stamps	0.0	100.0	.....	.....	.....	*2.0	9.3	14.3	.....	74.4	.....	Through 40 mesh.

* 50 mesh sieve used in place of the 60.


GOLD QUARTZ
STAMPS
HUNTINGTON
ROLLS
DODGE
SAMPLE GRINDER
PERCENTAGS OF ORE
50
40
30
20
10
.01
.02
.03
04
.05
DIAMETER OF GRAINS IN INCHES

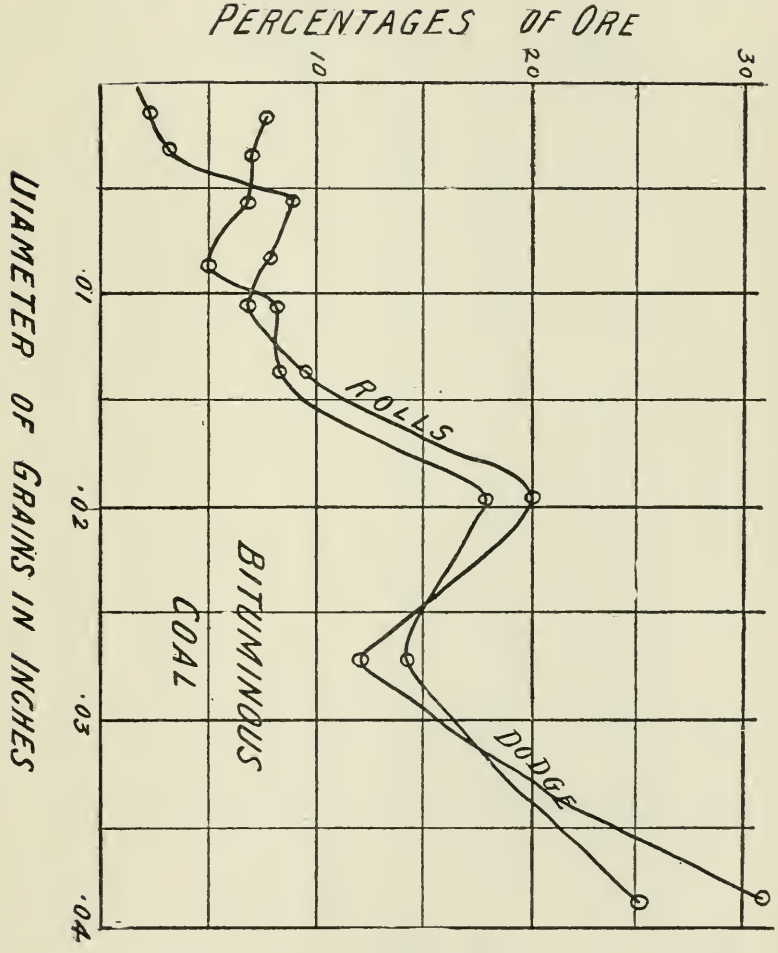
VII —Chromite in Serpentine from Eastern Townships.

Name of Crusher.	Over 14.	Under 14.	14–18.	18–24.	24–40.	40–60.	60–70.	70–100.	100–150.	150–200.	200–0.	Remarks.
Dodge	72·7	27·3	16·2	11·2	11·3	10·1	5·5	8·0	28·2	5·5	4·0	Set at ½ inch.
Huntington	0·0	100·0	.....	.....	14·5	16·5	16·2	16·0	31·0	4·2	1·8	Through 30 mesh.
Sample Grinder	0·0	100·0	2·0	6·1	13·7	14·7	23·3	9·0	25·2	4·6	1·4	

VIII.—Coal.

Name of Crusher.	Over 14.	Under 14	14–18.	18–24.	24–40.	40–60.	60–70.	70–100.	100–150.	150–200.	200–0.	Remarks.
Dodge	94·83	5·17	36·1	19·2	23·2	*1·3	10·6	1·9	.....	7 7	.....	Anthracite.
Rolls	45·5	54·5	26·0	14·0	18·0	8·0	7·0	7·0	9·0	6 0	5·0	Anthracite.
Dodge	82·0	18·0	25·0	14·0	18·0	8·0	8·0	5 0	7·0	7·0	8·0	Bituminous.
Rolls	65·3	34·7	31·0	12·0	20·0	8·0	7·0	8·0	9·0	3·0	2·0	Bituminous.

* 50 mesh sieve used.


PERCENTAGES OF ORE
10
20
30
DIAMETER OF GRAINS IN INCHES
·01
·02
·03
·04
ROLLS
DODGE
BITUMINOUS
COAL

IX.—Hematite, Helen Mine, Michipicoten.

Name of Crusher.	Over 14.	Under 14.	14–18.	18–24.	24–40.	40–60.	60–70.	70–100.	100–150.	150–200.	200–0.	Remarks.
Dodge	97.95	2.05	34.0	19.5	14.5	9.7	2.5	2.5	2.5	5.0	9.8	Set to ½ inch.
Rolls	16.7	83.3	11.2	10.3	18.0	8.4	7.7	9.9	14.9	12.4	7.2	Touching.

X.—Calcite with Galena and Blende from Hastings Formation, Ont.

Name of Crusher.	Over 14.	Under 14.	14–18.	18–24.	24–40.	40–60.	60–70.	70–100.	100–150.	150–200.	200–0.	Remarks.
Dodge	73.8	26.2	16.8	13.8	23.0	*3.8	16.8	8.4	.....	17.4	....	Set at ½ inch.
Rolls	39.4	60.6	20.6	12.2	20.3	7.6	6.3	7.9	10.1	7.6	7.4	Touching.

* 50 mesh screen used.

XI.—Gold Bearing Quartz from Rat Portage.

Name of Crusher.	Over 14.	Under 14	14–18.	18–24.	24–40.	40–60.	60–70.	70–100.	100–150.	150–200.	200–0.	Remarks.
Dodge.....	87.2	12 8	21 8	14.8	21.2	*0.8	10.9	12.5	.....	18.0	.....	Set at ½ inch.
Rolls.....	37.8	62.2	25.0	25.5	16.4	8.8	10.5	5.3	5.6	1 9	1.5	Rolls touching.

* 50 mesh sieve used.

XII.—Tin Stone from Dolcoath Mine, Cornwall, England.

Name of Crusher.	Over 14	Under 14.	14–18.	18–24.	24–40.	40–60.	60–70.	70–100.	100–150.	150–200.	200–0.	Remarks.
Dodge.....	81.5	18.5	22.7	11.3	20.6	*0.5	22.7	5.9	.....	16.3	.....	Set at ½ inch.
Rolls.....	39.1	60 9	22.1	12.6	19.7	8.0	5.4	7.4	10.0	7.2	7.4	Touching.
Ball Mill.....	52.0	48.0	8.0	5.0	12.0	8.0	6.0	9.0	10.0	8.0	34.0	2 hour run.

* 50 mesh sieve used.

XIII.—Pyrite from Eustis, Que.

Name of Crusher.	Over 14.	Under 14.	14–18.	18–24.	24–40.	40–60.	60–70.	70–100.	100–150.	150–200.	200–0.	Remarks.
Dodge	85·5	14·5	12·4	8·4	22·2	*0·7	21·5	8·3	.....	26·5	.....	Set at ½ inch.
Rolls	27·7	72·3	17·2	9·9	19·6	9·9	7·5	9·6	12·5	6·3	7·5	Touching.

* 50 mesh sieve used.

XIV.—Pyrrhotite from Rossland.

Name of Crusher.	Over 14.	Under 14.	14–18.	18–24.	24–40.	40–60.	60–70.	70–100.	100–150.	150–200.	200–0.	Remarks.
Dodge	73·0	27·0	14·0	9·0	12·5	6·5	6·0	6·5	14·5	16·0	15·0	Set at ½ inch.
Rolls	48·5	51·5	15·0	8·0	15·0	6·0	6·0	7·0	11·0	13·0	19·0	Set touching.

XV.—Gold Bearing Arsenopyrite from Actinolite, Ont.

Name of Crusher.	Over 14.	Under 14.	14–18.	18–24.	24–40.	40–60	60–70.	70–100.	100–150.	150–200.	200–0.	Remarks.
Dodge.....	85·0	15·0	17·0	6·0	11·0	7·0	8·0	8·0	11·0	12·0	20·0	Set at ½ inch.
Rolls.....	61·0	39·0	18·0	8·0	16·0	8·0	7·0	9·0	17·0	10·0	7·0	Rolls touching.

XVI.—Comet Crusher. Set at ¾ inch.

Name of Crusher.	Over 30.	Under 30.	14–18.	18–24.	24–40.	40–60.	60–70.	70–100.	100–150.	150–200.	200–0.	Remarks.
Graphite.....	80·0	20·0	.....	2·0	30·5	12·0	11·5	12·0	19·0	9·0	4·0	In limestone.

W. G. FLINT, *Science*, '01,
McGill University, Montreal.

Determination of Lead in Ores by Fire Asssay.

By Douglas Lay, A.R.S.M., Kimberley, B.C.

The fire assay, dependent as it is upon many variables, is at best, an approximation only to the ultimate lead contents of the ore, and is strictly speaking applicable only to pure ores of medium or high grade. But since upon it smelting charges are based, and consequently ores bought and sold, in the great generality of cases admittedly inexact as it is, the method has been widely adopted.

In many institutions for the instruction of assaying, it is customary to start the beginner with dry lead assays, the prevalent idea apparently being that it is a somewhat elementary task, whereas all practice tends to point to the fact that the succcessful conduct of that operation requires considerable experience, and that it is in reality one of the most difficult of the fire assays. Moreover, text books on the subject of assaying seem to be singularly reticent regarding the difficulties likely to be encountered, and of the manner in which to cope with them. In view of these facts, the following inquiry into the sources of error in the fire assay, being the outcome of a somewhat wide practical experience with many and varying grades of lead ores, may be of interest.

In the first place errors may arise from :—

1. *Loss* of *lead* owing to
   (a) Volatilization.
   (b) Lead passing into the slag in chemical combination.
   (c) Spirting causing mechanical loss.
2. *The Presence* of *certain elements in the ore*, which under the conditions of the assay are also reducible, and pass into the button of lead simulating that metal.

The first source of error—loss of lead from the three causes mentioned, may be guarded against, and may be reduced to a minimum, by taking due and necessary precautions, but should elements be

present to any extent in the ore, which like lead are reducible, the fire determination, upon the face of it, breaks down altogether, and wet analysis must be resorted to. Zinc, copper, tin, antimony and bismuth, are susceptible of reduction in a similar manner to lead, but of these only zinc, copper and antimony are likely to be met with in lead ores, as a rule, and copper and antimony only will be of material effect (unless the amount of zinc present is excessive), and inasmuch as copper will be readily detected prior to assay, antimony will be likely to cause most trouble, and should the resulting lead button show the slightest signs of brittleness upon assay of an ore, a wet determination of the lead contents should be made. The following assays show that antimony when present even in small quantities is not volatilized to any extent, but passes mainly into the lead button, and to a lesser extent into the slag, since the conditions, which favour accurate estimation of the lead, also promote the more or less complete reduction of the antimony.

The fusions were made in a muffle, in a reducing atmosphere. Charges thus :—

Ore—10 grams,
Flux—30 grams,
Salt cover and 2 iron nails.

Flux composed thus :—
Bicarb. soda—16 parts, Carb. potash—16 parts, Borax—8 parts, Flour—5 parts.

DURATION OF FUSIONS 1¼ HOURS.

Per cent. Antimony in Ore.	Per cent. Lead in Ore wet analysis.	Per cent. Lead in Ore fire assay.	Condition of button resulting from fire assay.
0.63	54.2	53.6	No evidence of brittleness.
0 90	55.7	54.7	Slightly brittle.
1.35	55 3	54.9	Buttons crack under the hammer.
1.80	54.8	54.8	
2.70	50.3	51.0	
3.60	47.7	48.5	

Since then it is impossible to guard against this latter source of error, it would seem that attention should centre upon the *loss* of lead

from the various causes mentioned, and upon the *conditions* affecting that loss.

First as regards *loss* of *lead*:—

Loss by volatilization.—While lead and its compounds are sensibly volatile at comparatively low temperatures when exposed to the air, yet it must be borne in mind that, in process of assay, the reduced lead, and that still undergoing reduction, are covered with slag and so protected, while the temperature during the greater part of the operation is low, hence it would seem improbable that a material amount of lead would be volatilized provided the proper conditions prevailed.

Loss in the Slag.—Whatever properties the flux used may possess, a certain chemical loss of lead is bound to occur in the slag, since complete reduction, under the most favourable conditions, cannot be effected. The analysis of slags from a number of very carefully conducted assays showed a mean percentage of 0.62 per cent. lead. Further investigation showed that this chemical loss largely increases with the temperature, and that in cases of improper firing, it may amount to almost double this last figure.

The following assays will illustrate the loss in the slags as compared with that by volatilization. The assays were made in precisely the same manner, as regards amount and proportion of the charges of ore and flux, and duration of fusion as those above quoted:—

Per cent. Lead in Ore wet analysis.	Per cent. Lead in Ore fire assay.	Difference between wet and fire assays in units of Lead.	Per cent. Lead in slag wet analysis.	Weight of slag from fire assay (approximate)	Units of Lead accounted for in slag.
50.9	49 2	1.7	0.62	28 grams.	1.7
52.2	50.7	1.5	0.53	28 "	1.5
52.7	51.1	1.6	0.47	29 "	1.4
62.6	61.0	1.6	0.53	28 "	1.5

It would seem from these analyses that the greater part of the missing lead can be accounted for in the slag, taking the difference between the wet and fire determinations as representing the ultimate loss. The loss by volatilization in these instances must therefore of necessity have been not appreciable.

Loss from Spirting.—This mechanical loss of lead caused by too high initial temperature is probably the greatest source of error—a conclusion justified by the evidence afforded both by observation and experiment.

The following are typical of the loss which may be occasioned by this cause :—

Charges of ore and flux same as before :

Per cent. Lead in Ore. Time of fusion 1¼ hours.	Per cent. Lead in Ore. Time of fusion ½ hour.	Per cent. Lead in Slag from quick fusion, by wet analysis.
53.6	51.0	Slags average 0.74 per cent. Pb.
54.5	52.9	
51.0	50.1	
49.4	47.1	
61.2	59.3	
53.0	51.0	

Second as regards the *conditions* which affect the loss of lead.

The loss of lead from the various causes considered, may be said to depend essentially upon, and to be governed by the following factors :—

(1). The temperature and duration of the fusion.

(2). The atmosphere, neutral reducing or oxidizing in which the fusion is conducted.

(3). The nature and properties of the flux employed.

Temperature.—The great secret is to *start* the assays at a *low* temperature. For the first 45 or 50 minutes, it should not exceed that of *incipient* fusion of the charge—dull redness (say about 550° C), and should then be gradually raised till at pouring it about equals that of a gold assay. The total time of the operation should be from 1—1½ hours—certainly not less than 1 hour—carbonate ores not requiring so long for their reduction as sulphides.

While a low initial temperature is a *sine qua non* of success, as guarding against loss of lead by spirting and a minor loss by volatilization, yet on the other hand the temperature during the earlier stages must not be too low, otherwise the necessary reactions will not have

taken place, and the right conditions will not have been arrived at when the temperature is raised, and the results will be vitiated.

The atmosphere in which the operation is conducted should be reducing. In the case of a muffle furnace, this may be attained to by placing a few pieces of charcoal in the front part of the muffle, and a more even temperature throughout the muffle is also thereby engendered. This measure ensures conditions which combat volatilization of lead. Protected by a layer of slag and surrounded by an envelope of reducing gas, loss from this cause is minimized. Arsenic, when present in any considerable quantity would seem to promote this loss.

The Flux.—The essential features of a good lead flux may be stated thus :—

(1). It must be readily fusible to protect the lead from volatilization.

(2). It must contain excess of carbon.

(3). The amount of borax present must not be excessive, otherwise lead will tend to pass into the slag chemically combined as a borate.

(4). It must act as a desulphurizer.

The following well known lead flux composed of :—

Bicarb. soda	16 parts.
Carb. potash	16 "
Borax glass	8 "
Flour	5 "

When used in the proportion of 3 of flux to 1 of ore, with a salt cover and a couple of iron nails in the charge, will be found to give satisfactory results in the case of oxidized and sulphide ores alike.

Upon an average, in the case of ores of medium and high grade, *free from interfering elements*, the wet assay exceeds the dry by about 1.7 per cent., though in some instances the dry assay can undoubtedly be made to more nearly approach the wet.

The writer desires rather to emphasize the fact that the conclusion that in a properly conducted fire assay the main loss of lead is occasioned not by volatilization but by chemical combination in the

slag, is outborne by analysis, though he is well aware that it is somewhat at variance with the views of some, who lay great stress upon the volatility of lead, seeming to hold it up as the main source of error.

It may be said in favour of the fire assay that rapid determinations can be made which satisfy many technical requirements, but it must be acknowledged that rapidity in this case is quite incompatible with accuracy. At best the determination is unsatisfactory, inasmuch as while the errors involved may be reduced to a minimum, their total elimination is impossible. It would seem then that these facts argue strongly for the speedy and general adoption of the wet method (with a certain arbitrary deduction) as a basis for settlement in the case of the buying and selling of lead ores, as is the custom with copper ores to-day.

In conclusion, it may be said that the views expressed in the foregoing, have been arrived at by the writer, after making upwards of 10,000 lead determinations in almost every kind and grade of ore, pure and impure, and after he has been checked up by other chemists in the case of upwards of 1,000 samples.

Pioneer Work in the Crows Nest Coal Areas.

By Wm. Blakemore, M.E., Montreal.

At the moment of commencing to write, news comes to hand of the sudden demise of Dr. G. M. Dawson, the respected head of the Geological Survey of Canada, and it is imperative that anyone professing to treat upon the subject of this paper should, under the sad circumstances, pay a tribute to the value of those splendid services, which he so faithfully rendered to the country; and especially is it fitting that I should do this because he was the first authority to recognize the value and possibilities of these coal areas. He passed through the country in 1881, and although there was only time for a cursory examination, his keen perception, and intuitive scientific genius enabled him to prepare a monograph, the accuracy of which has been fully established by subsequent detailed surveys; and for the geological data upon which this paper is based, I wish to acknowledge my indebtedness to Dr. Dawson's reports, which were of the greatest assistance, when first opening up the coal seams for active operation.

But whilst Dr. Dawson may be called the scientific pioneer of the Crows Nest Pass, and the first to realize its enormous importance and value, it is right here to tender a meed of praise to the men who first discovered the existence of coal and, especially, to the one man whose name is most intimately associated with this district. It was in the late seventies that Mr. William Fernie, in company with his brother, whilst prospecting near Martin Creek for gold first noticed coal float in the bed of the streams, and was led by this to make a more careful examination of the steep mountain sides, and finally to discover at an elevation of about 6,000 feet the outcrop of a 30 foot seam of coal. Although this was Mr. Fernie's first experience in dealing with anything but the precious minerals, he was shrewd enough to conclude that it might be a find of considerable importance, and from that date until 1896, when the Crows Nest Pass Coal Co. was formed, with Mr. Fernie as a Director, in season and out of season, through good and

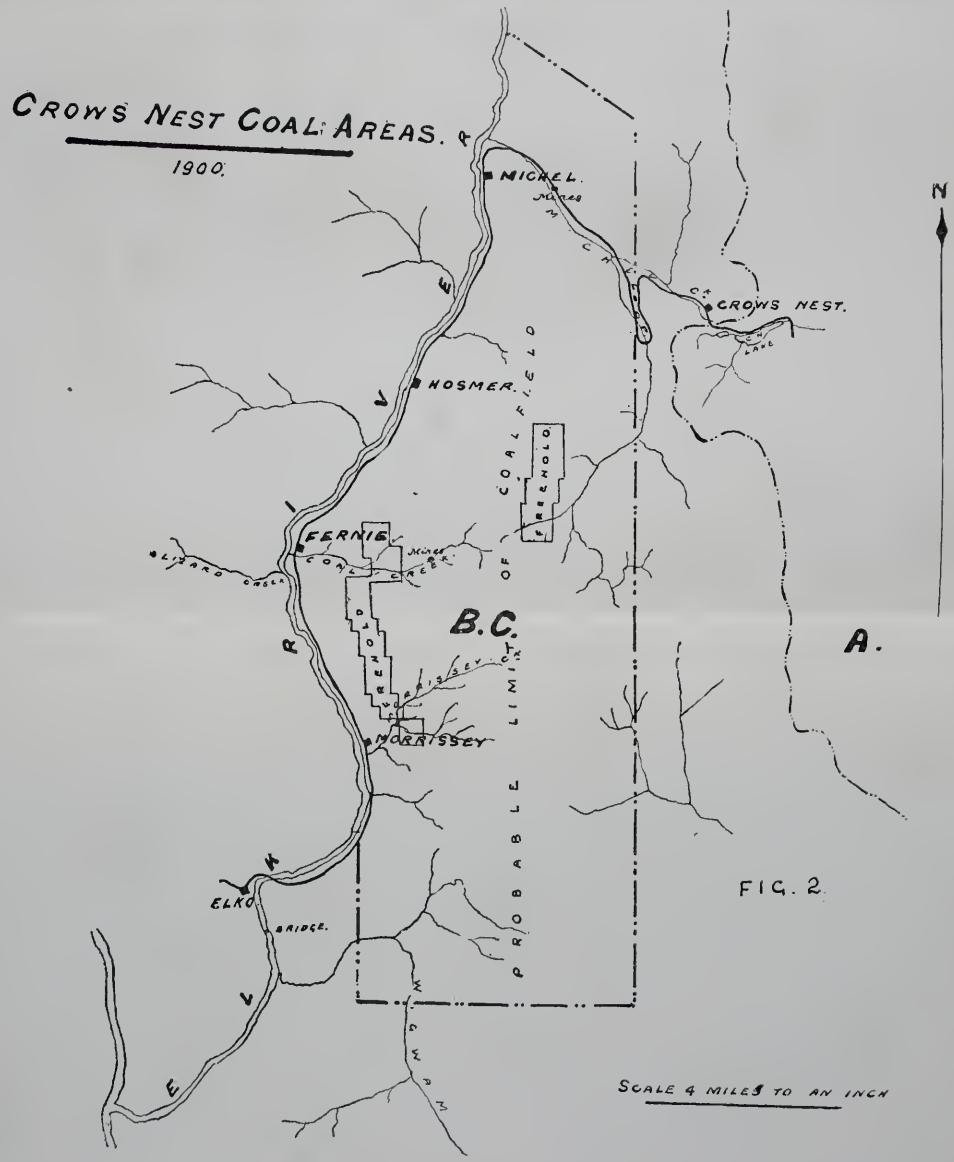

CROWS NEST COAL AREAS.
1900.
MICHEL.
CROWS NEST.
LAKE
HOSMER.
COAL FIELD
FERNIE.
COAL CREEK
B.C.
A.
MORRISSEY
PROBABLE LIMIT OF
ELKO
BRIDGE.
N
SCALE 4 MILES TO AN INCH

FIG. 2.

evil report, in the face of opposition—which at times threatened to swamp the undertaking—he never ceased to labor and scheme for the building of a railway and the development of mines; devoting all his time and pledging his last dollar, and it is only a fair tribute to his British pluck and energy to say, that but for the tenacity and ability with which he clung to his pet scheme, there probably would not have been either a Crows Nest Railway or coal mine to-day. Mr. Fernie has had a remarkable career, of which this, possibly the most important coal project in the world, is a fitting climax. The son of an English country doctor, educated and trained to follow his father's profession, at twenty he ran away to sea, sailed nearly round the world, reached San Francisco in the early fifties, became a gold miner there and, subsequently, in British Columbia ; being one of the earliest pioneers of the Fraser River placer mining, and afterwards going with the rush into the Cassiar and Caribou country. Attracting public attention he became Gold Commissioner and Government Agent, and for some years ruled the Indians and miners with a rod of iron in the Fort Steele division of East Kooteney, winding up his career in connection with the Crows Nest coal areas. To-day, at sixty-five years of age he has retired to enjoy a well earned rest, and it is some satisfaction to know that the reward of his industry has furnished him with ample means to do so.

I have dwelt on personal matters to this extent because it is not always that the men who deserve credit in connection with onerous and difficult mining enterprises get it, and there is certainly no calling in which high qualities of character are more often demonstrated.

The coal areas referred to lie longitudinally upon the western side of the first range of the Rocky Mountains near the boundary, which separates British Columbia from Alberta. Coal seams are found in the lower Cretaceous formation, and are inter-stratified principally with sandstone and shales, super-imposed upon carboniferous limestone, and below this proceeding westerly we find the Cambrian rocks The extent of the coal field is theoretically ninety miles long, running north from the south fork of the Elk River, but the actual limit of the coal basin, which is undisturbed, and can be counted upon to yield workable coal, extends only a distance of forty miles north of this point where the

limestone comes to the surface, and the coal measures are so broken up and disturbed as practically to terminate at a point four or five miles north of Michel Creek. The exact southern limit is from four to five miles south of Morrisey Creek. The western limit of the basin is defined by the Elk River, all along the west bank of which the limestone outcrops and forms precipitous mountains. The eastern limit is determined by a line running north and south, at an average distance of nine to ten miles from the Elk River. Allowing for the large areas which have been eroded between the various mountain peaks in the creeks, it is probable that the nearest estimate obtainable of the area of workable coal is not less than 150 square miles, and Dr. Selwyn, the late head of the Geological Survey, computed the available coal to each square mile at 24,976,000 tons.

The coal measures lie in a long and narrow synclinal trough, the strike being due north and south. The western outcrops upon the mountain sides are at an elevation of from 1000 to 2000 feet, and upon the eastern side near Martin Creek, from 500 to 1000 feet above the level of the trail As the creeks are traversed they gradually rise into the measures and the outcrops are exposed on the level of the trail which gives the easiest possible access. The question of the exact extent of this basin will be determined by the geological survey, which is now being conducted, but the limits here given are probably correct. It is possible that there may be areas of detached coal between the limestone ridges a considerable distance north of Michel Creek, but there can be no large area favourable for working outside the basin indicated. The southern boundary is easily determined by the character and pitch of the rocks, all of which are much disturbed, and are frequently flexed with over-turning folds to the east. Along the trail which crosses the North Kootenay Pass the Cretaceous rocks are found, dipping to the north at an angle of 40 degrees, and at this point there is also a large fault with a throw to the east of not less than 1,500 feet. Another large fault crosses the River Elk near the bridge, so that while the coal seams have been found outcropping in the south fork or Wigwam River they cannot extend any considerable distance in that direction. Dr. Dawson estimated that the exposures in the Crows Nest Pass indicate a total thickness of 7,000 feet of Cretaceous

measures and 9,610 feet of limestone, and it is worth noting that his estimate at the Crows Nest summit and the North Kootenay Pass is the same.

In connection with the geological formation of this coal field, there are two interesting problems, one of which has been solved, and the other is in a fair way to solution. The first only became a problem in 1893, when disregarding the opinion expressed by Dr. Dawson in his reports of 1882 and 1885, the theory was broached that this coal basin contained two distinct series, which were designated the Elk River series and the Martin Creek series. The former was declared to contain twelve seams, with a total thickness of 151 feet of coal, and the latter twenty seams with a total thickness of 132 feet. This has been proved to be an error: there is really only one series. The exact number of seams has not yet been ascertained, as the areas are not fully prospected, but the result will be to cut down the workable seams of bituminous coal to something like eight or ten, and to reduce the aggregate thickness to 120 feet. In the former computation a large number of seams of bituminous shale were included, under the head of "Cannel" coal, but no true "Cannel" has been discovered, and these can be eliminated. In this connection it is worth quoting the opinion of Dr. Dawson in his report of 1885, at page 76, B. where he says: "The horizon is probably identical, and the general effect of the section is that of a wide, low synclinal, there is also every reason to believe that the coal bearing horizon here met with is the same as that discovered east of the Crows Nest Lake, and though the exposures are few near the main or water-shed summit, it is not improbable that the same horizon may be found there occupying the trough of a synclinal midway between the upper summit and the crossing of the east branch of Michel Creek."

The second problem mentioned has reference to the possible extension of these coals on the eastern side of the Rockies, in the direction of what is known as the Gap. As the Cretaceous formation is found here great hopes have been expressed that the same class of coal would be discovered. These hopes have not yet been fulfilled, although excellent coals have been found. At Livingstone a seam 6 feet

6 inches thick has been prospected by tunnelling to a depth of several hundred feet, and further south near to the Mormon settlement at Cardston, a number of sections have been taken up, which contain outcrops of valuable coal, on the banks of the St. Mary River. This coal shows an analysis 4.05 per cent. of ash, and 91.20 of volatile combustible matter and fixed carbon, and by fast coking yielded a firm, coherent coke. It is too soon yet to pronounce definitely upon how it will compare with the Fernie coals, but further exploration in this direction will be carefully watched.

The pioneer work in the Pass, with which the writer is more closely identified followed that dealt with above, and commenced in 1897. Called upon to open up these seams in a new country and amid conditions the most unfavourable, it was at the time no easy task. The location decided upon for first openings, Coal Creek, was then 105 miles from the nearest railway station, Fort Macleod, and forty miles from the Crows Nest summit. The country all along the valley of the Elk was heavily timbered with magnificent belts of tamarac, fur, spruce and cedar running as high as 300 feet, and with trunks six to nine feet in diameter. The under growth was dense and there was no clearing and no passage except the Indian trail. The difficulty of commencing mining operations was greatly increased by the fact that these could not be delayed until the railway was constructed, the company being under an obligation to furnish coal by a given date, in order to secure their land grant, so it became a race between railway and coal mine. The railway construction was commenced at Fort Macleod in July, 1897, and the prairie road, as far as the summit, was available in March, 1898.

Meanwhile operations had been commenced in the coal measures at Coal Creek in November, by the gang of men who were taken in to assist in prospecting. The first miners employed arrived in December, 1897, and were Welsh-men, they pitched their tent and hung out a sign claiming to be the pioneer coal miners of the Pass. The railway did not reach Coal Creek until August, 1898, and meanwhile supplies of every kind had been hauled, at first from Fort Macleod and afterwards rom the summit over a "tote" road, the like of which has probably

never been seen in the west. Much of the material had to be "packed" in, and a "pack train" of ten to twenty horses was kept constantly at work, the cost, when roads were at their worst in the spring, running as high as five cents a pound from the summit to the mine. This was due largely to the execrable character of the road, which after leaving the summit, and especially along the low lying valley of the Elk River was a simple clearing over-soil consisting of five to six feet of alluvial mud. The character of the road can best be imagined from the experience of the writer, who, with a first-class team never made the journey from the summit to Coal Creek, a distance of thirty-three miles in less than two days, and often required three. In spite, however, of these drawbacks. when the railway reached the mine there was a stock of 10,000 tons of coal banked out, and more than 4,000 feet of heading had been driven. Plant and machinery of every kind had been so ordered as to reach the mine as soon as the railway was open, and 100 car loads of material was waiting at various points, between Winnipeg and Macleod to be pushed through when the road was ready. With a plentiful supply of timber near at hand it was possible to get all bridge and trestle work hewn and hauled into position, and within four months of the railway reaching Coal Creek everything was in running order, there was a daily output of 300 to 400 tons of coal and 50 coke ovens were producing coke.

As the coke industry was the "raison d'etre" of the establishment of these works it is appropriate that I should refer to the quality of the coke although it is not necessary three years after it has been in the market to say anything in its praise.

I will simply remark that regarded in all aspects there is no other coking coal in the world which is equal to it, even the celebrated Durham coal which furnishes the next best coke is inferior in purity.

I append the following comparative analysis of coke:—

	Carbon.	Ash.
Crows Nest, British Columbia.....	91.97	8.03
Crested Butte, Colo	89.00	11 00
Cardiff & Sunshine, Colo.....	87.18	12.82
Belt Montana washed coal.....	91.00	9.00
Connellsville, Pa.....	86.88	11.54
Trinidad, Colo. washed coal.	85.00	15.00

Another analysis of a seam which has not yet been worked, but of which I took a sample, shows even better than this, viz., carbon 95.98, ash 4.02. An average analysis of the raw coal gives fixed carbon 73.04, volatile matter 21.13, water 2.75, ash 3.08, the yield of coke varies from 68 to 73. To make one other comparison let us take two of the most celebrated Welsh coking coals, the Park, which gives in coke as follows: Carbon 89 72, ash 8 50, and the Ogmore patent coke made in the Coppee ovens: carbon 92.26, ash 7.74 From this it will be seen that Crows Nest coke does not suffer by comparison with the very highest standards. The effect of putting such a coke as this upon the market is well known to most of you, in that it has entirely replaced Welsh and Connellsville coke, which had to be imported at enormous cost to help out the very inferior local coke, which was previously obtainable. The cost of this imported coke ranged from $15.00 to $20.00 a ton, laid down at the smelters, whilst Crows Nest coke costs about $7.00, and the reduction in smelter charges already effected has been largely due to this factor The coal, whilst not an ideal one for domestic purposes, is still far better than any other obtainable in the West, and with a strong draught burns admirably in stoves, but is not satisfactory in open grates, as it cakes and becomes dead. For blacksmithing purposes it is an ideal coal on account of its great heat and its comparative freedom from sulphur. For steam getting it has demonstrated its superiority to any other western coal. It is worth noting here that two years ago the British Admiralty took 500 tons at Victoria, for a test upon the Admiral's Flagship which was just then starting for England by way of the Horn. So satisfactory was the result that I received a cablegram from the first calling place, Matanzas, stating that the Admiral had found it to give much better results than anticipated, and was so enamoured of it that he had cabled to the Lords of the Admiralty requesting them to arrange for its use on the Pacific Coast. When development has proceeded further and a larger tonnage is available there is no doubt that the English and American Pacific squadrons will use this coal. The question of a general market need not be discussed, beyond saying that, with such an unlimited supply there should be no difficulty in meeting all requirements, and I am satisfied that the

quality of the coal and coke is such, that it must dominate the western market entirely. It is as indispensable to our American cousins across the border as to Canadians, and I anticipate that in less than five years this coal field will supply the entire consumption of coke in British Columbia, Montana and Washington Territory, and probably 50 per cent. of the raw coal required. Allowing only for a moderate development this would mean a daily output of not less than 10,000 tons of coal, and possibly more.

We must glance in passing at the conditions on which this coal-field is occupied, and the safeguards which the legislature has wisely enacted in the interests of the country. The local legislature of British Columbia and the Federal Parliament, by legislative enactment, have made over to the Crows Nest Pass Coal Co. by way of subsidy for the construction of the railway, 250,000 acres of coal lands, of which however, 50,000 have to be ceded to the Government to be disposed of as they see fit in the interests of the country, in order to secure an adequate supply of this coal to the public at a reasonable price. The protection thus sought to be given is a very necessary one, and the clause embodying it is carefully drawn, for it explicitly states that the 50,000 acres shall be of "equal value as coal lands with the residue of the coal lands." These words "of equal value" practically determine not only the question of quality in the coal but of location and access. The only practicable entry to the coal seams of the Crows Nest basin is in the creeks, because on the mountain sides the outcrops are too high and except in the creeks there is practically no flat-land at the base of the mountains upon which to erect the necessary works. All that is necessary, therefore, is that the Government shall see that this clause is complied with, and the selection judiciously made in accordance with the spirit of the provision.

I will conclude by briefly describing the appliances, plant and machinery installed at Coal Creek for the operation of the first mines opened there. I may state that the mines are five miles from the town of Fernie, the latter being situated on the banks of the river Elk There is an electric power plant, which furnishes power for lighting the surface and mines, coal cutting, pumping and hauling. It is driven by

a Polson horizontal engine, 16 x 16 inches, at a steam pressure of 100 lbs. The dynamo, is driven by a twelve inch belt, and runs 600 revolutions per minute. It is a direct current, constant, potential dynamo, 150 horse power, over-compounded 10 per cent. It supplies pressure on the line at 220 volts. The capacity of the dynamo is 250 volts or with no loading 400 amperes. There are two Polson locotubular boilers, supplying steam at 100 lbs. pressure. The main haulage is conducted upon three systems, necessitated by the exceptional undulation of the floor, and I may here remark that this is one of the greatest difficulties to be contended with in mining these seams. It is not uncommon to start with a normal pitch of fifteen degrees, find this flattening out gradually until the coal becomes level, this pitching down again at twenty degrees. This actually occurred in the first main dip and of course disorganized the haulage. Upon the main level haulage is operated for 3,000 feet by a Jeffrey electric locomotive of seventy horse power. The weight of the locomotive is 2,000 lbs., there is an over-head wire and the haulage works on the trolley system. This installation has been thoroughly successful and has worked upon an even steeper grade than it was designed for. Upon a grade varying two to four degrees against the load it has hauled out 1,000 tons in twenty-four hours. The secondary haulage is supplied by an electrically driven stationary hoist of twenty-five horse power. It is geared between the armature and the drum at a ratio of one in twenty-five, which gives the rope a speed of two miles an hour. This hoist hauls up a main dip of an angle of fifteen to twenty degrees against the load. It is stationed 1,500 feet inside the mine and works satisfactorily. From the working places to the mechanical haulage the coal is conveyed in cars drawn by horses. There is an installation of coal cutting machinery consisting of two electrically driven coal cutting machines, of the chain type, supplied by the Jeffrey Co. These have not been as successful as expected owing entirely to excessive grades and the irregularity of the pavement which makes it difficult to move them from stall to stall, but when in operation they have given the best results and upon easier grades have demonstrated their capacity. An installation of compressed air is now being made for the purpose of

introducing percussion cutters which will probably be more suitable in such steep seams. The method of working adopted is the "pillar and stall," it being impossible to resort to longwall under such an enormous cover. It has been found necessary to leave very large pillars and in spite of this the crushing has been sufficient to close one section of workings. It must be remembered that this coal is exceedingly soft and friable and does not stand well, even where the pillars are left of exceptional size. It may yet be necessary to resort to square work, the system generally in use in the Old Country in thick seams.

At the present time the output at Coal Creek is from 1,200 to 1,400 tons a day, and is expected to be largely increased this year. It may be worth noting that the output in 1898 was about 60,000 tons; in 1899 100,000 tons; in 1900 240,000 tons.

The ventilation is produced by two of Murphy's reversible fans, yielding respectively thirteen, and seventy thousand cubic feet of air per minute. These however, were only installed temporarily for development work. There is a large Chandler fan, fifteen feet in diameter, capable of producing 300,000 cubic feet of air per minute, with a water gauge of three inches, and other installations of ventilating machinery will shortly be made in consequence of the large quantity of gas yielded by the workings. In this connection it should be noted that the altitude of the mine, about 4,000 feet, gives very low barometer readings, varying from 24 to 25 inches: and during atmospheric depressions the pressure per square inch does not exceed twelve pounds. Add to this the fact that a large quantity of coal dust is produced, and it will be seen that great care has to be exercised in connection with the ventilation. A thorough system of watering has been introduced with excellent results. Very little pumping is required in the mines at present and the only machine in use is a Tripley pump, electrically driven. It has a three horse power motor, 220 volts, 400 amperes, and is geared direct to the crank shaft, at a ratio of twenty to one. The diameter of the pump rams is three inches, length of stroke three and a half inches, number of strokes sixty, capacity seventeen gallons per minute.

Upon the surface in addition to the power plant, already referred

to, there is a large and costly trestle, which had to be built from one side of the creek to the other, 1,000 feet, in order to give access from the workings to the screen house; it has an elevation of thirty feet, with four parallel tracks, and the locomotive runs right up to the dump. There is a large screen house containing a modern equipment of shaking screens, twenty feet long by five feet wide, with a working speed of 100 strokes per minute by six inch stroke. The inclination of the shaker is seventeen degrees dip towards the discharge. The large coal passes over this screen to a travelling picking belt, sixty feet long and five feet wide, which moves at the rate of forty feet per minute and discharges all the large coal into the cars. Nuts pass through the first screen and fine through a second screen, so that there are three divisions of coal; all the fine is taken to the coke ovens. The tippler, which plays an important part in dealing with the whole of this output is a Mitchell. It is capable of dealing with 2,000 tons in ten hours, and is so arranged that the falling cars release the wheel grips of the empty car; after it has been emptied they run forward down a five per cent. grade for a distance of fifty feet then back on another track, falling five per cent. for the same distance to the side of the tippler. Having reached this point by gravity it is taken hold of by a "creeper chain," which lifts it up a fifteen degrees incline to a sufficient height to permit it again to run forward by gravity to the empty track, ready for attaching to the locomotive. The whole of this plant which is operated by an engine 12 x 12, the motive power being conveyed by chains and sprocket wheels, was manufactured by I. Matheson & Co., of New Glasgow.

The surface tracks are arranged in the "gridiron" fashion" being parallel and connected both at the extreme elevation and at the lowest point with the branch line. When a train of empty cars is brought in it is pushed above the top switch and left there; the cars are then allowed to fall by gravity, as required, and are diverted by the switch to whichever track is necessary. Afterwards they fall by gravity also below the screen house to the siding where the out-going train is made up, in this way no mechanical power whatever is required on the surface. The grade of the siding is .75 degrees.

The coke ovens are erected five miles from the mine, at Fernie,

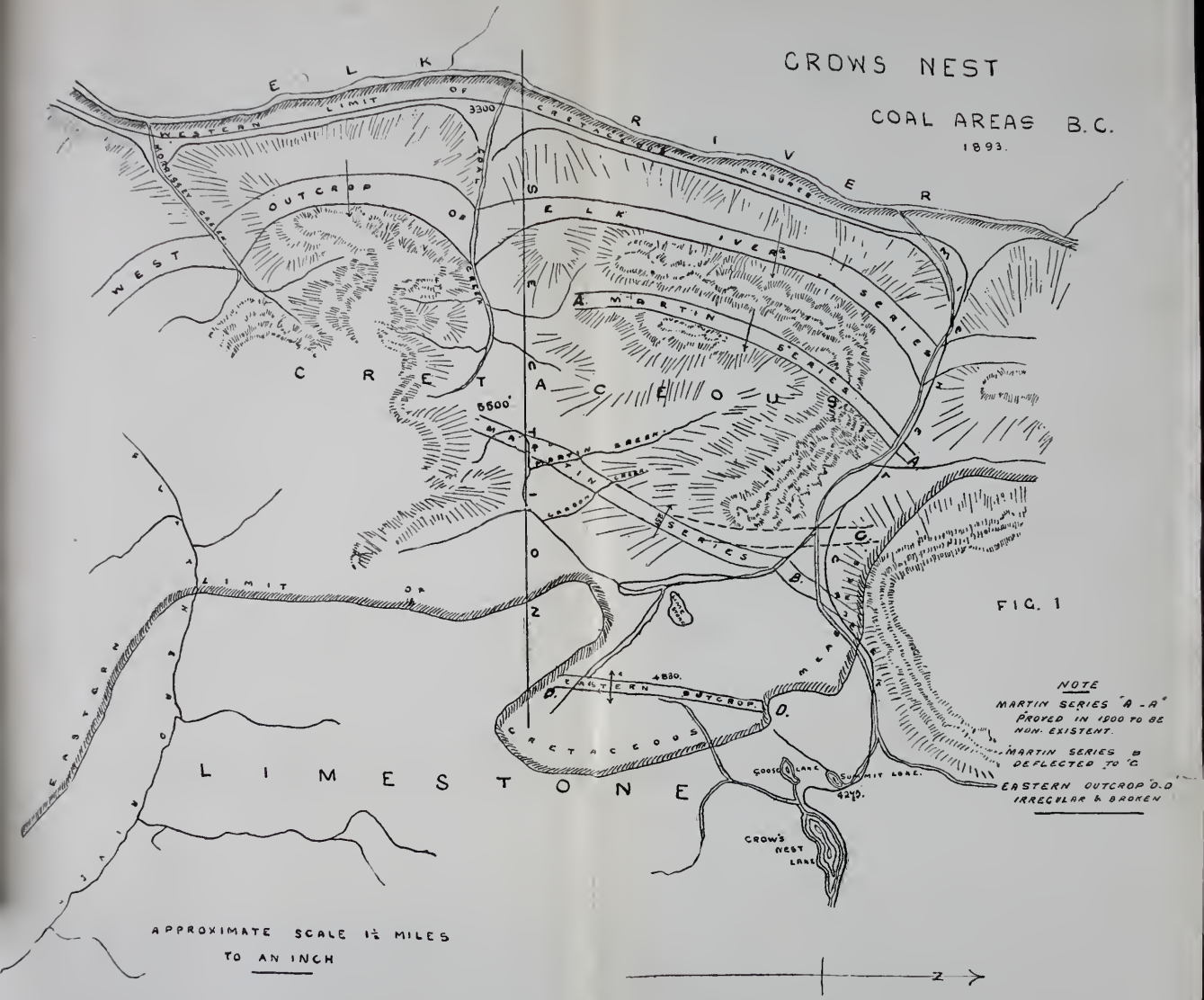


FIG. 1

NOTE

MARTIN SERIES "A-A" PROVED IN 1900 TO BE NON-EXISTENT.

MARTIN SERIES DEFLECTED TO "C"

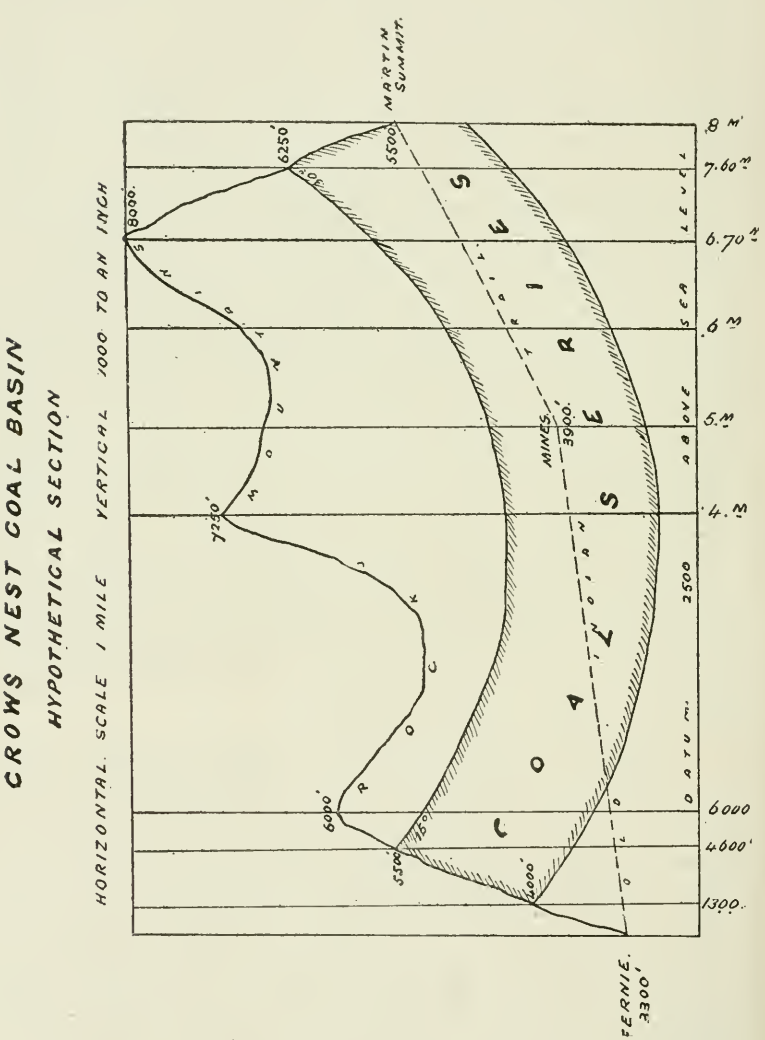
EASTERN OUTCROP "D.D" IRREGULAR & BROKEN

The same [illegible] are erected five miles from the mine, at Perm,

upon a large plateau. At present there are 312 in operation. There is a special arrangement of tracks and bins to ensure the most economical handling, and as a matter of fact from the moment the coal is loaded into the cars at the working places in the mine until it is raked out of the ovens in the form of coke it is never touched by hand. It falls automatically from the tippler to the screen, is separated and passes into the railway cars, falls by gravity from the screen to the out-going siding, is hauled by a locomotive to the side of the coke ovens, where it is discharged through bottom door hoppers into a large bin, with a storage capacity of 5,000 tons. From the under side of this bin a low level track passes, with a slight falling grade to the top of the coke ovens and an electrically driven lorry carries the coal the full length of the ovens and discharges through a side shute into the holes. The ovens are of the ordinary bee-hive shape, twelve feet in diameter. They are placed in double rows, and the railway track runs between each set of ovens at a distance of about thirty feet from the doors. The average charge of coal is 6.5 tons (of 2,000 lbs.); the production of coke per charge averages 4.50 percentage, in coke 68 per cent. Time of burning seventy-two hours, average output for each oven per day 1.5. The ovens are built of sandstone, which is quarried in the Pass, and are lined with fire-bricks, which have to be imported either from Scotland or Pennsylvania. The cost of these bricks laid down reached the enormous figure of $70.00 per thousand, and it is to be hoped that a suitable fire-clay may yet be discovered in the Province

Although not directly a branch of mining it is necessary to say that in such a country, as I found at the Crow's Nest Pass in 1897, mining operations were not the only ones which had to be conducted. A townsite had to be selected, cleared, divided into lots, sold, and built upon. Many of you have been there; to those who have not I may say that in one year from the time that operations commenced the town of Fernie was one of the most prosperous in British Columbia, with a population of nearly 2,000 people, with a water works system, electric lighting for the streets and houses, good side-walks and a prosperous community.

This sketch is only intended to give a general idea of the opening


CROWS NEST COAL BASIN
HYPOTHETICAL SECTION
HORIZONTAL SCALE 1 MILE VERTICAL 1000 TO AN INCH
MARTIN SUMMIT.
6250'
5500'
6000'
7250'
6000'
3500'
3000'
MINES
3900'
COAL MEASURES
DATUM.
2500
ABOVE SEA LEVEL
8 M.
7.60 M.
6.70 M.
6 M.
5 M.
4 M.
6000
4600'
1300'
FERNIE.
3300'

up of a new concern in what has been called the "Wild and Woolly West," but which from my experience I would be disposed to call the "Wild and Woody West." The Crow's Nest Pass coal areas have had a start, and they will well repay for watching I consider that they will furnish the key to the success of western mining and settlement. They certainly contain one of the most valuable, if not the most valuable, of our mining deposits,and long after those who were engaged in the pioneer work of the section have been called to another sphere, western Canada will be enjoying the fruits of their labours.

Company Law.

By J. M. Clark, M.A., LL.B., K.C.

Mining operations are now so generally carried on by joint stock companies with limited liability that it is somewhat difficult for us to realize that such companies are, so far as English law is concerned, a modern invention.

It was not till 1855, less than half a century ago, that the principle of limited liability was introduced. It was only in 1825 that the famous Bubble Act was repealed. That Act was passed in 1719, 6 Geo. 1 chap. 18 to prevent the formation of dangerous and mischievous companies tending to the grievance of the subjects of the realm. Under this statute a company with shares transferable without restriction was held clearly mischievous. A learned Chief Justice thought such a company tended to introduce gaming and rash speculation to a ruinous extent to the grievance of numbers of His Majesty's subjects. In fact it is well known that the modern idea of a joint stock company met with the most strenuous opposition. Dryden condemned it as a scheme to divide the empty nothing into shares and set the public by the ears—Carlyle denounced it as a mischievous invention.

The idea however has made rapid progress. In England the paid up stock of such companies amounts to over five billion dollars. There they have gone from unlimited liability to limited liability; in Ontario following the example of some of the Western States—we have gone a step further and have mining companies with no personal liability by the shareholders on their stock.

In all mercantile communities questions as to the formation, organization and management of joint stock companies have in recent years received great attention.

In the United States the science of corporations has been greatly developed. There every possibility of corporation law for good or evil has been exploited. In Germany and France there are provi-

sions tending to discourage the investment of small sums in company shares.

In Great Britain the Board of Trade appointed a committee to enquire what amendments were necessary in the Acts relating to joint stock companies incorporated with limited liability, especially with a view to the better prevention of fraud in relation to the formation and management of companies and to consider a report upon the clauses of a draft Bill which was laid before them for that purpose.

This committee, which was appointed on November 12th, 1894 made their report on the 27th June, 1895. In that report the general lines upon which, and the limits within which, the Legislature can safely or usefully interpose are discussed and the committee say :—

"It is a trite observation that legislation cannot protect people "from the consequences of their own imprudence, recklessness or want "of experience. The Legislature cannot supply people with prud- "ence, judgment or business habits. It must be remembered that the "majority of companies are honestly formed for carrying on a "legitimate though it may be a speculative enterprise or business, and "the business is conducted with honesty and reasonable ability and "judgment. In consequence partly of the facilities which exist for "the formation of companies in this country a vast amount of foreign "enterprise and foreign business comes to England. Banking, rail- "way, and other business is now carried on in every quarter of the "globe by British capital and managed by British officials. Accord- "ing to the recent report of the Board of Trade there were in the "United Kingdom in April, 1894, 18,361 companies with a paid up "capital of 1,035,029,835L., whereas the capital of all companies in "France, *anonymes* and *en commandite*, was, in December, 1894 "calculated approximately at 420,000,000L. The capital of German "companies was estimated by Mr. Gerb of H. M., Consulate General "in Berlin at 200,000,000L., but Mr. Schuster puts it at 300,000,000L. "The capital embarked in English companies therefore exceeds that "represented by French and German companies together by at least "315,000,000L. The number of persons who are interested either as "shareholders or bond or debenture holders in these companies is of

" course enormous. It is obvious that legislation affecting interests of " this magnitude and widespread character demands great caution " and care. Restrictive provisions, which may have the effect of " either curtailing the facilities for the formation of companies which " bring so much business to England or of embarrassing the adminis- " tration of companies, or deterring the best class of men from becoming " Directors, are not to be lightly entertained."

In the course of their investigation the committee came upon a curious instance which they record in their report, where a company was registered in January, 1891 whose capital of £10,000 was divided into 9,600,000 shares of one farthing each and the total subscribed capital was one penny and three farthings.

The committee report that they dismissed from their consideration every suggustion for public enquiry by the Registrar or other official authority as to the soundness, good faith and prospects of the undertaking at the commencement or any other stage of a company's formation.

" On the other hand, it must be generally acknowledged that a " person who is invited to subscribe to a new undertaking has " practically no opportunity of making any independent inquiry before " coming to a decision. Indeed, the time usually allowed between " the issue of the prospectus and the making of an application does " not permit of any real investigation. The maxim of *Caveat Emptor* " has in the opinion of your committee but a limited application in " such cases."

The ultimate result of the report of this committee was that after much further consideration and many alterations of the draft Act, there was passed the Companies Act, 1900 (63 and 64 Victoria, Chapter 48). This Act provided that the certificate of incorporation given by the Registrar of joint stock companies should be conclusive evidence that all the requisitions of the Companies Act in respect of registration and of matters precedent and incidental thereto had been complied with, and that the association is a company authorized to be registered and duly registered under the Companies Act. This is an exceedingly important provision, and prevents points which created

great anxiety under the previous legislation from being agitated. These points were matters considered in what is known as the "one man company" case, *Saloman vs. Saloman & Co.* (1897 A.C. 22).

The Act requires a Statutory declaration as to the compliance with these requisitions, and provides that the incorporation of the company shall take effect from the date of incorporation mentioned in the certificate of incorporation. This section of the Statute is expressly made retroactive.

Another very important provision in the new English Act is that contained in section 2, that a person shall not be capable of being appointed director of a company by the articles of association, and shall not be named as a director or proposed as a director of a company in any prospectus issued by or on behalf of the company unless he has by himself or his agent authorized in writing (1) signed and filed with the Registrar a consent in writing to act as such director. (2). Either signed the memorandum of association for a number of shares not less than his qualification, or signed and filed with the Registrar a contract in writing to take from the company and pay for his qualification shares, if any.

Stringent provisions are made in regard to the qualification of directors. What is one of the most important features of the Act is contained in section 4, which provides that no allotment shall be made of any share capital of a company offered to the public for subscription unless the following conditions have been complied with, namely: The amount, if any, fixed by the memorandum or articles of association, and named in the prospectus as the minimum subscription upon which the directors may proceed to allotment, or

(b) If no amount is so fixed and named, then the whole amount of the share capital so offered for subscription has been subscribed and the sum payable on the application for the amount so fixed and named, or that the whole amount offered for subscription has been paid to and received by the company.

This will effectually prevent the practice, which gave rise to grave scandals, of going to allotment on an obviously inadequate subscription. so that the company was from the start doomed to

failure. This amount is referred to as the minimum subscription, and the amount so fixed and named is to be reckoned exclusively of any amount payable otherwise than in cash, and the amount payable on application on each share shall not be less than 5 per cent. of the nominal amount of the share.

If these conditions have not been complied with on the expiration of forty days after the first issue of the prospectus, all money received from applicants for shares shall be forthwith repaid to the applicants, without interest. This section provides that any condition required or binding any applicant for shares to waive compliance with any requirement of this section shall be void.

An irregular allotment in contravention of the provisions of the Act is made voidable at the instance of the applicant, within one month after the holding of the Statutory meeting, and directors are made personally liable for any loss, damages or costs which the company or the allottee may have sustained.

Section 6 of the Act places salutary restrictions upon the commencement of business by a company. These provide that a company shall not commence any business or exercise any borrowing powers unless shares held subject to the payment of the whole amount thereof in cash have been allotted to an amount not less in the whole than the minimum subscription. (b). Every director of the company has paid to the company on each of the shares taken or contracted to be taken by him and for which he is liable to pay in cash a proportion equal to the proportion payable on application and allotment on the shares offered for public subscription, and that there has been filed with the Registrar a Statutory declaration of compliance with the provisions of the Act.

This section also provides for the giving by the Registrar of a certificate that the company is entitled to commence business, and that such certificate shall be conclusive evidence that the company is so entitled.

This provision is open to the objection that it will give the public an unreal sense of security.

The Act also provides for returns as to allotment, and permits the payment of commissions for subscriptions.

In the previous company legislation there were attempts to define what should be in the prospectus of a company. The Directors' liability Act of 1890 was framed largely for this purpose, but it was a dead letter. The present Act provides that every prospectus shall be dated, and that a copy of such prospectus shall be signed by every person who is named therein as a director or proposed director of the company, or by his agent authorized in writing, and shall be filed with the Registrar on or before the date of its publication. The Registrar is prohibited from registering any prospectus unless it is so dated and signed, and the Act provides that no prospectus shall be issued until so filed for registration, and that every prospectus shall state on the face of it that it has been so filed.

Section 10 provides:

"(1). Every prospectus issued by or on behalf of a company, or by or on behalf of any person who is or has been engaged or interested in the formation of the company, must state:—

(a) The contents of the memorandum of association, with the names, descriptions, and addresses of the signatories, and the number of shares subscribed for by them respectively; and the number of founders or management shares, if any, and the nature and extent of the interest of the holders in the property and profits of the company; and

(b) The number of shares, if any, fixed by the articles of association as the qualification of a director, and any provision in the articles of association as to the remuneration of the directors; and

(c) The names, descriptions and addresses of the directors or proposed directors; and

(d) The minimum subscription on which the directors may proceed to allotment, and the amount payable on application and allotment on each share; and in the case of a second or subsequent offer of shares, the amount offered for subscription on each previous allotment, and the amount actually allotted; and the amount, if any, paid on such shares; and

(e) The number and amount of shares and debentures issued, or agreed to be issued, as fully or partly paid up otherwise than in cash, and in the latter case the extent to which they are so paid up, and in either case the consideration for which such shares or debentures have been issued or are proposed or intended to be issued; and

(f) The names and addresses of the vendors of any property purchased or acquired by the company, or proposed so to be purchased or acquired, which is to be paid for wholly or partly out of the proceeds of the issue offered for subscription by the prospectus, or the purchase or acquisition of which has not been completed at the date of publication of the prospectus, and the amount payable in cash, shares, or debentures, to the vendor, and where there is more than one separate vendor, or the company is a sub-purchaser, the amount so payable to each vendor; and

(g) The amount (if any) paid or payable as purchase money in cash, shares, or debentures, of any such property as aforesaid, specifying the amount payable for good-will; and

(h) The amount (if any) paid or payable as commission for subscribing or agreeing to subscribe, or procuring or agreeing to procure subscriptions, for any shares in the company, or the rate of any such commission; and

(i) The amount or estimated amount of preliminary expenses; and

(j) The amount paid or intended to be paid to any promoter and the consideration for any such payment; and

(k) The dates of and parties to every material contract, and a reasonable time and place at which any material contract or a copy thereof may be inspected: Provided that this requirement shall not apply to a contract entered into in the ordinary course of the business carried on or intended to be carried on by the company, or to any contract entered into more than three years before the date of publication of the prospectus; and

(l) The names and addresses of the auditors (if any) of the company; and

(m) Full particulars of the nature and extent of the interest (if

any) of every director in the promotion of or in the property proposed to be acquired by the company, with a statement of all sums paid or agreed to be paid to him in cash or shares by any person either to qualify him as a director or otherwise for services rendered by him in connection with the formation of the company.

(2). For the purposes of this section every person shall be deemed to be a vendor who has entered into any contract, absolute or conditional, for the sale or purchase, or for any option of purchase, of any property to be acquired by the company, in any case where :—

(a) The purchase money is not fully paid at the date of publication of the prospectus; or

(b) The purchase money is to be paid or satisfied wholly or in part out of the proceeds of the issue offered for subscription by the prospectus; or

(c) The contract depends for its validity or fulfilment on the result of such issue.

(3). Where any of the property to be acquired by the company is to be taken on lease, this section shall apply as if the expression "vendor" included the lessor, and the expression "purchase money" included the consideration for the lease, and the expression "sub-purchaser" included a sub-lessee.

(4). This section shall not apply to a circular or notice inviting existing members or debenture holders of a company to subscribe for further shares or debentures, but, subject as aforesaid, this section shall apply to any prospectus whether issued on or with reference to the formation of a company or subsequently: Provided that:—

(a) The requirements as to the memorandum of association, and the qualification, remuneration, and interest of directors, the names, descriptions, and addresses of directors or proposed directors, and the amount or estimated amount of preliminary expenses, shall not apply in the case of a prospectus published more than one year after the date at which the company is entitled to commence business; and

(b) In the case of a prospectus published more than one year after the date at which the company is entitled to commence business, the obligation to disclose all material contracts shall be limited to a

period of two years immediately preceding the publication of the prospectus.

(5). Any condition requiring or binding any applicant for shares or debentures to waive compliance with any requirement of this section, or purporting to affect him with notice of any contract, document, or matter not specifically referred to in the prospectus, shall be void.

(6). Where any such prospectus as is mentioned in this section is published as a newspaper advertisement, it shall not be necessary to specify the contents of the memorandum of association or the signatories thereto, and the number of shares subscribed for by them.

(7). In the event of non-compliance with any of the requirements of this section, a director or other person responsible for the prospectus shall not incur any liability by reason of the non-compliance, if he proves that :—

(a) As regards any matter not disclosed, he was not cognisant thereof; or

(b) The non-compliance arose from an honest mistake of fact on his part :

Provided that in the event of non-compliance with the requirements contained in paragraph (m) of sub-section (1) of this section, no director or other person shall incur any liability in respect of such non-compliance, unless it be proved that he had knowledge of the matters not disclosed.

(8). Nothing in this section shall limit or diminish any liability which any person may incur under the general law apart from this section."

The Act contains exhaustive definitions of who vendors are, and provides for non-compliance with any of the requirements of the section, and provides that any waiver of compliance with this section shall be void.

One of the most striking features of the new Act is the provision for the Statutory meeting, which must be held within a period of not less than one month or not more than three months from the date at which the company is entitled to commence business. Careful provisions are made to make this Statutory meeting a reality, and to

ensure that the shareholder before the meeting shall have full and complete information.

Another important section of the Act makes provision for the registration with the Registrar of joint stock companies of certain classes of mortgages and charges which are defined by the Act. These are not complete, and as to certain other classes of mortgages and charges not covered by the Act, the law is left as it was before.

Provision is made for the rectification of the Registrar, and for penalties for non-compliance with the requirements of the Act, and for the enforcement of such penalties.

The contents of the annual summary required by section 26 of the Companies Act of 1862 are extended, and the present Act requires such summary to be so framed as to distinguish between the shares issued for cash and shares issued otherwise than for cash, or only partly for cash, and shall give certain other information.

Careful provisions are made in regard to the appointment of auditors, their remuneration, rights and duties, but these are not so stringent as the drastic provisions at one time proposed.

Important provisions are made as to the winding up of companies, and as to defunct companies, and for the purpose of rectifying certain abuses in regard to companies limited by guarantee.

Penalties are provided for false statements under the Act.

This most important legislation went into effect on the first of January, 1901, and its working will be watched not only in England but elsewhere with the keenest interest. In Canada the law at present is in a state of unfortunate confusion and embarrassing complication, and it is to be hoped that after a careful study is made of the working of this English legislation company law in Canada, not only the Dominion law but that of the various Provinces, will be placed on a more satisfactory basis. A comprehensive codification of the law affecting joint stock companies is quite feasible and would undoubtedly prove a great public convenience.

Concentration of Argentiferous Galena as carried on at Helena Frisco Consolidated Company's Mills, Gem, Idaho, U.S.A.

By W. Muir Edwards, Montreal.

The subject of my paper this afternoon is the Concentration of Argentiferous Galena as carried on at the Helena Frisco Consolidated Company's Mills, in which I worked as vanner man about four months last summer. The mine, the treatment of whose ore this paper deals with, is situated in the Coeur d'Alene district—a district justly celebrated for its lead and silver mining. The country is very mountainous and although at first the prospects were opened up and worked by shafts sunk on the outcrop, now most of the mines are worked by a tunnel driven into the hill to cut the vein, and a vertical shaft sunk on the vein. The Helena Frisco mine is worked by a tunnel about ¼ mile long, driven in to cut the vein at the 600 ft. level, and a vertical shaft sunk at this point, which last summer had reached the 2,200 ft. level. Levels are driven every 200 ft., and the mine is operated by a system of over-hand stoping. The stopes are permanently timbered, and everything taken out of them is put through the mill.

Material Treated.

The material to be treated consists of an Agentiferous Galena, a considerable amount of zinc sulphide and a dark colored country rock with a hardness of about 4½ and a specific gravity much less than that of either the lead or zinc sulphides, in fact the difference in the specific gravity of the lead and zinc is so small as compared with that of the Galena and the country rock that the latter is never seen at the point of concentration, the separation being entirely between the lead and zinc sulphides.

The Galena is of two varieties, one a very fine grained, and the other a coarse grained having a good cubical cleavage.

The silver is carried largely by the cryptocrystaline variety, and its percentage varies slightly in different parts of the mine. It is usually quoted in the mill concentrates as running 22 oz. to the ton.

The zinc occurs both in the powdery form distributed through the Galena, and also in the massive form. The presence of zinc however, in large quantities is not universal throughout the Coeur d'Alene district. Some mines, the Hecla for instance, have no zinc at all, while others have not as high a percentage as the Frisco which with the Tiger Poorman are about the worst in this respect. The process of separation is, of course, much simpler where there is no zinc sulphide in the material. The large specimen on the table marked A gives a very good idea of the material to be treated in the Frisco. In it can be seen the waste rock, both varieties of the Galena, and also, the powdery form of the zinc; the massive zinc also showing.

General Description of Mill.

The plant for separating these different constituents is contained in a 750 ton mill situated at the mouth of the mine tunnel. It is a five storey structure built up the side of the mountain, narrow at the top where the crushers are placed and broadening out for the jig and vanner rooms below. On the fifth floor are the crushers. Between the fifth and fourth floors, but in an extension by themselves, are the Pelton water wheels, four in number, which drive the coarse mill, the fine mill, the slime mill and the dynamo which supplies light to the mill and mine. Each of these is separated and may be speeded up, slowed down or shut off independently. On the fourth floor are all the rolls which are used in the mill—the dry rolls set immediately in front of the bin into which the crusher feeds; the Allis rolls which receive the middlings from the coarse jigs, and three fine rolls which crush the middlings from the fine jigs. On the third floor are the arrangements for classifying the feed for the different concentrating machines below. These consist of a separation by two sets of trommels, followed by an hydraulic classification as the feed passes down a launder over the jigs, followed by a settling out of the coarser slimes as the overflow from the jig launder flows through a tank above the tables, and a

final settling out of the finer slimes as the round tables' overflow passes down a long tank behind the vanners. The second floor is the concentrating floor on which are the jigs, round tables and vanners. On the first or ground floor are the ore-bins, slime concentrate bins, apparatus for weighing and loading the ore, settling tank for mill overflow and also a lower vanner room.

Detailed Process.

As the mine and the general arrangement of the mill have been described, we might now consider somewhat in detail the treatment of the ore. The process is as follows—the ore is run out of the tunnel in a string of cars pulled out by a horse. The cars which are then on a landing a storey above the crusher floor are weighed, run over and dumped into a bin having a capacity of about 60 cars, which is behind and above the crushers. From this bin the ore slides over a grizzly down which it is raked by the crusher man to the crusher. The fine material passes through the grizzly and under the crusher, thus saving a needless waste of power. While being raked over the grizzly the feed is also cleaned of the wood, spikes, broken hammers, candle hooks, etc., which necessarily are mixed with it.

The crushing apparatus consists of two Blake crushers, one a 10 x 20 in., and the other a small emergency crusher 10 x 15 in. placed alongside in case the big one should have to be shut down for repairs. The capacity of the larger crusher is such that it can put through more than the jigs can handle. The jaw plates are set from 1 in. to 1 ¼ in. apart, the size of aperture varying slightly as owing to the fact that everything is put through the mill, the character of the feed varies a good deal. The crushed material falls into a bin from which it is fed by a shaker to the coarse or dry rolls. This feeder is a long shallow box shaken lengthwise by a cam and spring attachment, which is adjustable so that any desired feed may be given to the coarse rolls.

The rolls are 30 in. diameter, and 15 in. across the face. They are set ¾ in. apart and run at the rate of 34 R.P.M. From these rolls the feed slides by gravity to the trommels.

The trommels consist of two sets. The first set comprises two

exactly similar trommels 6 ft. long x 3 ft. in diameter, each having two divisions with 10 m.m. and 15 m.m. holes respectively. They are set side by side, the left hand trommel handling the direct feed from the coarse rolls, while the similar trommel alongside handles the recrushed coarse-jig-middling from the Allis rolls.

The second set consists also, of two similar parallel trommels, 8 ft. long by 3 ft. in diameter, having three equal divisions with 3, 5 and 7 m.m. holes respectively. Each of these trommels handles half of the mixed feed passing through the 10 m. m. holes of the first set. All of the trommels are revolved by gear wheels at the rate of 20 R.P.M. and run wet, being watered by a row of spouts running along above them.

The feed is thus divided according to size, with 6 separate portions—the oversize of the 1st set, material between 10 and 15 m. m., the oversize of the 2nd set, material between 3 and 5 m. m., and material finer than 3 m. m. The last two portions pass on to be further classified for the feed of the fine jigs, tables and vanners. The other four portions comprise the feed of the coarse jigs. As it would be tedious to enter into a detailed description of the throw, R.P.M. size of sieve and other particulars in regard to both the coarse and fine jigs, I submit information drawn up in tabular form giving the feed, the R.P M., the number of compartments in which concentrate is made, both Hutch and Top, and similar information of the middlings, the size of sieve used in the different compartments and finally whether tailings are made or not.

All of these jigs, with the exception of the Bull jig, which is a three compartment single jig, are four compartment ones, arranged in sets of twos placed back to back, each set handling one portion of the classified feed. The plunger is worked directly by an eccentric on a shaft run from an overhead pulley. The throw in the different compartments is not given in the tabulated statement because it varies a good deal, the variation depending not only on the feed treated but also on the fit of the plunger. It can only be stated that the Bull jig has an eccentric throw of from 2½ to 2 in., and that the rest of the coarse jigs have a throw varying between 1½ to 1 in. The throw in the fine jigs decreases from ⅞ down to ⅛ in. as the feed gets finer, but there

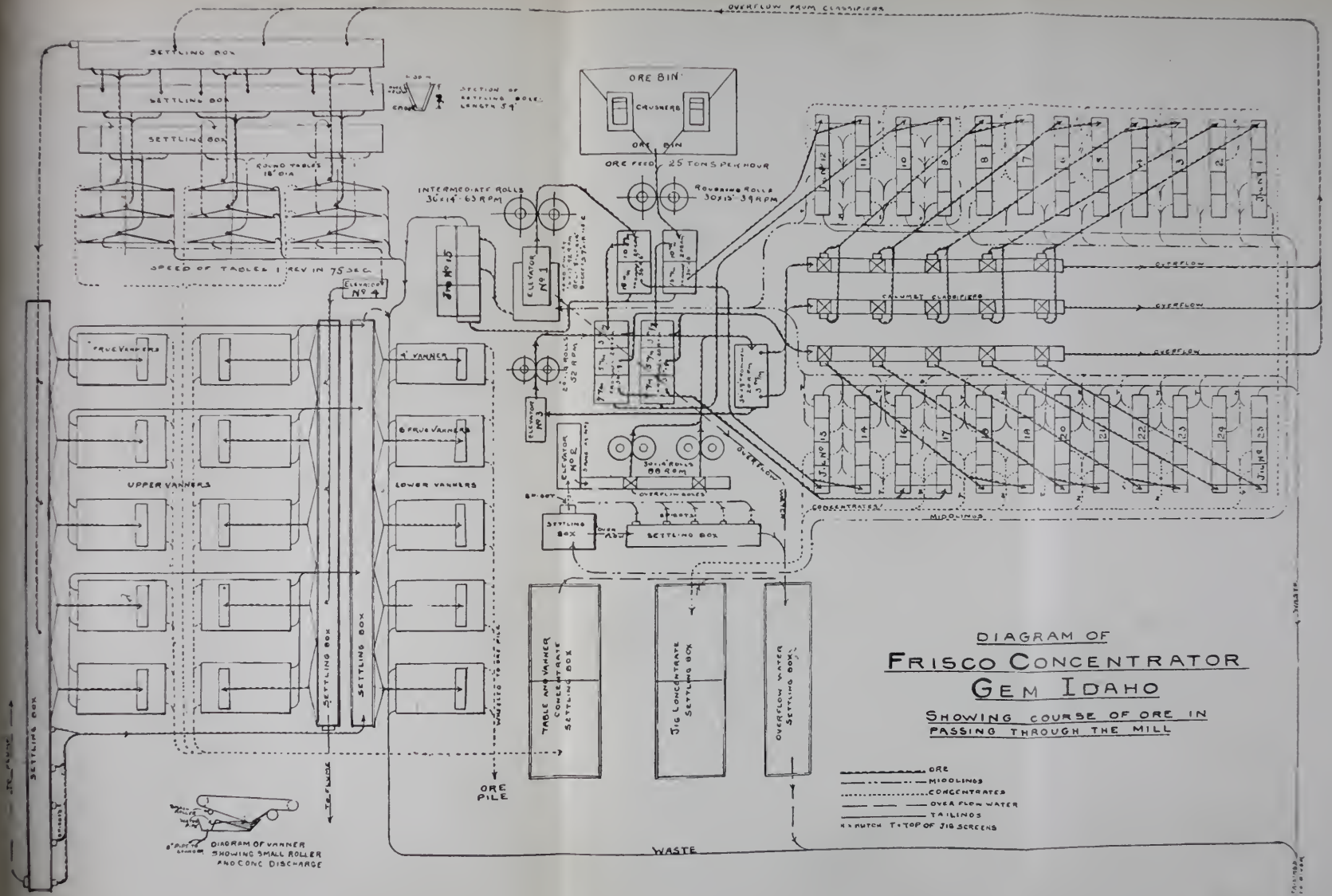
is no uniform decrease, the lack of uniformity being not so noticeable as in the coarse jigs.

The coarse jig room contains the Bull jig and four sets of jigs, the extra set being provided to handle half of the feed from the 15 m.m. holes of the first trommel.

The concentrates from these coarse jigs are led down by pipes to the ore-bin below. The middlings are led down to an unwatering tank on the lower floor and are then raised by a bucket and belt elevator up to the roll floor, where they are put through a pair 36 by 14 in. Allis rolls. They then pass into the left hand trommel of the first set and so start through the mill again. The tailings go direct to the tail race.

This finishes the concentration carried on in the coarse mill as it is called, which comprises the crushers, the dry and Allis rolls, the two sets of trommels, No. 1 elevator and nine jigs. This mill is run by a separate Pelton water wheel and may be shut off independently of the rest of the mill. This is an important consideration especially as regards the slime mill which may be kept running even if the coarse, or fine mill for that matter, has to be shut down to repair the elevator, or on account of choked rolls an event which happens frequently.

We have now to consider the concentration carried on in the fine and slime mills. It will be remembered that the feed smaller than 5 m. m. passes on to be further classified. This is first done by a Calumet classifier running along above the "direct" fine jigs. This classifier consists of a launder with boxes on the side opening into the main launder and having rising currents of water of varying intensity in them. The heaviest particles naturally settle out in the upper boxes and a separation according to the heaviness of the pieces is thus made. The feed thus classified and the different portions led to suitable fine jigs below the overflow passes on to the round table tank. The particulars of these jigs are given in the tabulated statement and need not be described here. The concentrates from these jigs are led to the ore-bin below. The middlings from these fine jigs are run to an unwatering box on the lower floor in front of No. 2 elevator. The settled material in the box is run into the elevator through a gate at the bottom of the box. The over flow passes to a long tank from the


OVERFLOW FROM CLASSIFIERS
SETTLING BOX
SETTLING BOX
SETTLING BOX
ROUND TABLES 18' DIA
SPEED OF TABLES 1 REV IN 75 SEC.
SECTION OF SETTLING BOXES LENGTH 54'
ORE BIN
CRUSHERS
ORE BIN
ORE FEED 25 TONS PER HOUR
INTERMEDIATE ROLLS 30"x14" 63 RPM
ROUGHING ROLLS 30"x15" 39 RPM
ELEVATOR No 1
ELEVATOR No 2
ELEVATOR No 3
ELEVATOR No 4
Jig No 15
Jig No 16
4' VANNER
6 FRUE VANNERS
FRUE VANNERS
UPPER VANNERS
LOWER VANNERS
SETTLING BOX
SETTLING BOX
SETTLING BOX
SETTLING BOX
SETTLING BOX
SETTLING BOX
TABLE AND VANNER CONCENTRATE SETTLING BOX
JIG CONCENTRATE SETTLING BOX
OVERFLOW WATER SETTLING BOX
ORE PILE
WASTE
CALUMET CLASSIFIERS
OVERFLOW
OVERFLOW
OVERFLOW
CONCENTRATES
MIDDLINGS
Jig No 1
Jig No 2
Jig No 3
Jig No 4
DIAGRAM OF VANNER SHOWING SMALL ROLLER AND CONC DISCHARGE
DIAGRAM OF
FRISCO CONCENTRATOR
GEM IDAHO
SHOWING COURSE OF ORE IN PASSING THROUGH THE MILL
ORE
MIDDLINGS
CONCENTRATES
OVER FLOW WATER
TAILINGS
H = HUTCH T = TOP OF JIG SCREENS

bottom of which the settled material is tapped by spiggots and this is also run into the elevator. The overflow of the tank passes to the main settling tank of the mill. The elevator takes the middlings up to the roll floor, where they are run into an inclined launder behind the pair of fine rolls to which it is fed by gates.

These rolls are Allis wet rolls 30 in. in diameter and 14 in. width of face and run at the rate of 88 R.P.M. The feed is divided equally between the rolls from which it passes into a small trommel. This trommel is 8 ft. long, 36 in. in diameter, has a mesh of 3 m. m., and runs at the rate of 20 R.P.M. The oversize of this trommel passes into a small elevator which raises it to the roll floor again and passes it into the third pair of fine rolls. These are 24 by 14 in. rolls and run at the rate of 52 R.P.M. From these rolls the recrushed product passes again into the middling trommel. The feed passing through the mesh of this trommel is equally divided between two similar Calumet classifiers exactly similar and parallel to that on the direct feed side. In the fine jig room, and also in the vanner room, the recrushed middlings are treated, one, the left hand side, (travelling with the feed) and the direct feed on the right, an equal number of machines being provided for each.

The middling jigs are exactly similar in construction to the direct feed ones, but in practice no tailings are made unless the feed is very heavy, overflow water only being allowed to go into the tail race. This it will be seen throws a very heavy zinc feed on the middling vanners.

The middlings from these jigs are piped down to an unwatering box in front of No. 2 elevator and are elevated and recrushed. The concentrates of course pass to the ore bin below.

Bedding is used on all the fine jigs. It collects gradually itself on the direct feed side and is skimmed off and taken over to the middling jigs with a shovel. This has to be attended to frequently. The size of the bedding is shown in the samples.

The fine jig room contains in all eight sets of jigs, four on the direct feed side and four on the middling feed side. They comprise

what is known as the fine mill and are run by a separate Pelton water wheel.

The overflow from the three Calumet Classifiers passes over screens through which it falls into a tank above and behind the round table. This tank is 54 feet long and of a cross section as shown in the diagram submitted. The side of the tank near the bottom is pierced with a number of holes filled with big spigots which again have small holes in them plugged with small plugs about 3/8 inch in diameter. There are about ten of these holes behind each table. Half of these feed three at a time on the top table and the other five feed a similar tank below which in turn feeds the second row of tables. There are three tiers of tables, three in each tier, the middlings from the upper two comprising the feed of the lower table. The tables are 18 feet in diameter and have a speed of one revolution in 75 seconds. The concentrates from all three tables go direct to the slime concentrate bin while the tailings go direct to the tail race. The middlings from the lower table run down and into an elevator (No. 4) by which they are elevated to a settling tank behind the middling vanners. Samples of the round table concentrates, middlings and tailings are shown in bottles 22, 23 and 24.

The overflow from the round table tank runs into a long tank behind the direct feed vanners.

The feed, by a system of launders especially on the middlings side is made fairly uniform.

The upper Vanner Room contains ten vanners, five on the direct side and five on the middling side. They are the ordinary 6 ft. Frue vanners and run at from 205 to 210 R.P.M. The feed is from spigots in the bottom of the settling tank, there being five spigots about 1/4 inch in diameter opening into a launder snpplying each vanner. Two of these are kept running, the plugs behind the vanners being changed every half hour. This insures a more uniform feed and also places the feed on the vanners much thicker. There are two very good devices which are not met with on all Frue vanners. One consists of a small extra roller held tightly against the out side of the belt just below and behind the large front roller as shown in the diagram.

This cleans the belt very thoroughly and causes all the concentrates to fall into the box doing away with the heavy hoeing which is one of the hardest parts of a vannerman's work. The other device consists of a hole in the bottom of the concentrate box connected by a short pipe with a launder running into the slime concentrate bin.

A constant stream of water is fed into the concentrate box and this washes the concentrate into the launder and so carries it to the slime concentrate bin where it settles, thus doing away with all shovelling and transporting of the concentrate. The overflow from the vanner tank passes into a long covered tank outside the mill where the settled material is again drawn off by spigots and this feeds into the settling tank behind the lower vanners. The overflow from this last settling tank outside the mill passes to the tail race. The tailings of the upper vanner which runs about 2 per cent. lead run down to the settling tank behind the lower vanners.

In the lower vanner room there are four 6 feet and one 4 feet Frue Vanners. The feed from the outside overflow tank feeds in at the end and the tailings from the upper vanners feed in a different point along the tank and are therefore principally handled by some separate vanner.

The overflow from the feed tank runs into the tailing launder and helps to flush it out. The lower vanner concentrates are wheeled out by wheel-barrow and dumped in a pile preparatory to loading. The tailings which are expected to be kept 1½ per cent. go direct to the river.

Samples of vanner concentrates which should be between 50 and 60 per cent. lead, and of the direct and middling tailings are shown in bottles 25, 26 and 27.

The slime mill is run by a separate turbine and the speed of the vanners may be varied to suit the feed. Although the tables are also run with this turbine, the speed is altogether regulated to suit the vanners. The speed varies between 200 and 210 R.P.M.. the speed depending in the percentage of zinc, a very heavy zinc load necessitating a high speed.

The concentrates from the mill are run into bins and allowed to

settle, the overflow water passing into the mill settling tank. There are two ore bins and two slime concentrate bins, the feed being turned into one of each pair while the other is being cleaned out. The ore is wheeled out, weighed, run and dumped into freight cars in which it is transported to the smelter.

The mill is exceptional in not having the fine jig middlings ground in a Huntington mill. Most of the mills in the canyon have one or more Huntingtons. The need of one was felt however when a heavy feed was put on the mill, as the feed on the round tables was much too coarse causing a large loss in the tailings, the tailings running sometimes as high as 12 to 14 per cent. This also had the effect of throwing a heavy coarse feed on the middling vanners which was hard to handle since the latter had to be run at the same speed as was required to handle the direct feed which would not be appreciably affected. As the middling feed was the richer, however, when the tables get loaded, which they did sometimes to the depth of 2 inches, everything of course being then washed into the middlings, the vanners were speeded up to 220 to 230 and a very fair separation was made under these circumstances. The plans for installing three Huntingtons were in process of completion just before I left Experiments with the Halet table were also to be made, looking to a substitution of these for the round tables. Most of the other mills use Wilfley tables for treating a size between that treated by the round tables and the vanners. Wilfley tables had been used in the Frisco mill but had been discarded in favor of an additional number of vanners.

The motive power is obtained by tapping the creek which runs past the mill about a mile and a half up the canyon and leading the water by a flume to a point above the mill. From the penstock the water is led down by a 6 inch pipe to the Pelton water wheels, the feed pipes being connected although the turbines are separate. The mill may also be connected to an engine driven by steam when the water is too low in the creek. It is usually necessary to use this engine from September to March.

The mill comprising a 10 x 20 inch crusher, 5 rolls, 9 coarse

jigs, 16 fine jigs, 12 round tables and 15 vanners is designed to handle 750 tons every 24 hours. In practice however, good results are not obtainable with a larger feed than 600 tons. With this amount of feed per 24 hours the mill can separate the valuable material from the waste with only a loss of 3/8 per cent. in the mill tailings. A staff of seven regular mill men, comprising a crusher man, a roll floor man, two jig men, one vanner man and shift boss is employed to operate the mill.

I might just briefly compare the above practice with the German practice in similar ores as carried on at Clusthal in the Hartz for the description of which I am indebted to a report by Mr. C. Van Petersdorff in the Report of the California State Mineralogist for 1890. The chief differences are:—

First.—That in the German practice there is an elaborate preliminary hand-picking which with our high priced and non-interested workmen is not done extensively on this side of the Atlantic. At Clusthal for instance seven separate products were made by hand picking and each of them had a separate treatment. At the Frisco everything was put through the mill except when, as sometimes occurred, they were able to ship crude ore.

Again separation by sizing is carried on on much smaller material at Clusthal than at the Frisco. At the former establishment after an hydraulic separation, getting rid of the slimes, the coarse product was sized down as low as 1 m. m. while everything below 5 m. m. was sorted hydraulicly at the Frisco. There is also a difference in the treatment of the middlings. Those at Clusthal are recrushed by stamps, while at the Frisco, at least I suppose this is true by now, the middlings are recrushed by Huntington mills. The superiority of the American practice in this respect is however being recognized on the other side, I believe, and Scrantz mills, which are very nearly equivalent to Huntingtons are being installed instead of the stamp batteries. Finally in the general arrangement of the mill it is also noticeable that while at the Frisco the machines of the same kind are grouped together on one floor, viz., the rolls on the roll floor, the jigs on the jig floor, etc., the practice at Clusthal is to have the group of machines

for any one operation on the same floor, i. e. coarse crusher, screens and jigs on one floor, the fine crusher, screens and jigs on the next floor, etc., this latter arrangement does away with the elevation of the middlings but is very wasteful of "drip."

In conclusion permit me to say, gentlemen, that any opinion I have offered and any statements I have made in the course of this paper are based only on personal observations as a student workman in the mill, and while visiting other mills in the canyon, and on opinions gleaned in conversation with other mill men, therefore if I have made mistakes which are apparent to gentlemen present who have doubtless a more intimate acquaintance with the district or with the particular concentrating propositions presented, I trust you will pardon me.

The Iron Ore Fields of Ontario.

By WILLET G. MILLER, School of Mining, Kingston.

The iron ore fields to which I desire to refer more particularly are those in what we are now accustomed to call New Ontario. In order however to conform to the title of the paper I shall refer briefly to deposits in the older parts of the Province as well.

The iron ores of the Province are of the following kinds: (1) Bog Ore, (2) Magnetite, (3) Titaniferous Magnetite, (4) Hematite.

We have had in Ontario what may be called two periods of iron manufacture. During the earlier of these, dating from 1800 to about 1855, the ore made use of was of the bog variety, chiefly. This material was found in loose deposits of recent age situated in one of the older agricultural districts. The area in which the industry achieved the greatest success was in Norfolk county not far from the shores of Lake Erie. The method of mining this bog ore was very simple. Trenches or ditch like depressions were sunk in the soil and the pieces of ore of various sizes were picked by hand from out of the earth.

At the picturesque but now forlorn village of Normandale in the county referred to there was situated a small charcoal furnace all traces of which have now nearly disappeared. The iron produced here was used largely for the casting of stoves and kettles required by the pioneers and quite a trade was carried on with Hamilton, Toronto and other towns to the east. The writer has seen stoves made from this iron in the rural parts of the district not many years ago, long after traces of the furnace had all but disappeared.

It may be of interest to note that much of the charcoal used in the smelting of the Norfolk ore was produced it is said from the timber of the native Canadian chestnut which grows to a large size in that, the most southern district of Ontario. Traces of the old charcoal pits are yet to be seen here and there in the uncleared parts of the country. The eastern limit of growth of these trees is in the vicinity

of Hamilton and when they are mentioned they are often mistaken for the common ornamental tree of our towns and cities, the imported horse chestnut. Another tree which has a like limited area of growth in the Province is the black walnut which was also at one time a valuble timber tree along Erie's shores.

The writer takes a special interest in these bog ore deposits as it was in these that he first saw mining operations carried on—during a "boom" in iron long after the Normandale furnace had gone out of blast.

In the same district there are numbers of paint or ochre deposits. These have been worked at different times and are similar in origin to the bog ore deposits but in their case the iron oxide is more intimately mixed with earthy matter than is the bog ore.

In this first iron period, furnaces were also erected in the more eastern part of the Province but they were of less importance. The ore used in these was obtained from bodies occurring in the crystalline rocks of the Laurentian. The sites of the industry here were in Hastings county and on the Gananoque River. The furnaces brought only financial disaster to those connected with them, unlike the Normandale furnace which was run with success from 1822 to 1847. Besides supplying the local market this furnace shipped castings of various kinds across the lake to Buffalo and one shipload of stoves and other castings was sent to Chicago.

SECOND PERIOD.

The second period begins with the mining of ores in eastern Ontario for export across lake Ontario to the centre of the iron industry in the adjacent United States after the furnaces in the Province had ceased operations.

Looking over the Reports of the Geological Survey the first reference I have found to the exportation of iron ore from the Province, relates to the early fifties.

The first furnace, built after the closing down of the Normandale works in 1847, which has met with success, is that erected at Hamilton a few years ago, about 40 years after the closing of the Norfolk

furnace. This Hamilton furnace inaugurated a new era and has now two competitors for public favour, one at Deseronto and one at Midland, with two or three others as yet in embryo.

Leaving out of consideration the district in which bog ore was first mined as being now and for the future of no economic importance as a source of ore, our Ontario Ore Fields are divisible into two large areas or what may perhaps be more properly called regions, those of south-eastern Ontario and those of the northern and north-western parts of the Province.

These two regions are rather sharply defined both geographically and geologically.

The south-eastern region contains ores of economic value which occur, with the exception of a few pockets of Potsdam age, in what is known as the Grenville series of the Laurentian. Titaniferous magnetites, of no value at the present time as ores, occur here as well as in various other districts of the Province.

Then there are the deposits, which are now beginning to attract so much attention, which are found in what is known as the Huronian series in the north and west.

In all our geological literature a quite sharp distinction is made between the Grenville and Huronian series of rocks. Whether this distinction will be found to hold in the future is of little importance to us in connection with a consideration of their respective iron ore deposits of economic value. So far, however, as the characters of the iron ore deposits are concerned the two series are quite distinct. The enclosing and associated rocks in the two regions are quite different in origin and appearance.

In the south-east many of the magnitite deposits have one wall of crystalline limestone and the other of gneiss. In other cases gneiss is the enclosing rock on both walls.

In the newer districts of the Province the associated rocks are of totally different character and jasper or other closely related silicious material is a constant accompaniment of the ore bodies.

SOUTH-EASTERN ONTARIO.

We shall first deal with the ores of the first developed or south-eastern region.

The ores of economic interest here are of two kinds, magnetites and hematites. The former occur largely as contact deposits, as already stated, the wall on one side being in many cases composed of crystalline limestone while the other wall is some form of gneiss, often the scapolite-holding variety.

The two districts in this part of the Province which have been developed to the greatest extent are situated along the Kingston and Pembroke, the Central Ontario and the Irondale and Bancroft railways.

Along the first mentioned road the deposits which have been worked in recent years are found at different points for a distance of about 50 miles, beginning 30 miles north of Kingston. All the deposits recently worked here are composed of magnetic iron ore. Much of this is coarse in grain and thus differs in appearance from the characteristic fine grained and slaty magnetites of the north-western region. Outside of silicious material many of these ores are very pure but the ore from a few deposits contains enough sulphur to lower its grade.

Years ago some hematite deposits were worked in the district lying east of the K. & P. R., the most important being in Lanark county.

Along the C. O. R. the magnetite deposits which have attracted most attention are those of Belmont and Coe Hill although much has been done on a number of others. The deposit which has been worked most continuously along this line of railway is, however, composed of hematite and is known as the Wallbridge mine. Years ago this deposit was thought to have been worked out and was so described but during the last few years it has produced a considerable amount of good ore.

One of the chief reasons for the beginning of the construction of the Irondale R.R. was the transportation of iron ore from a number of deposits known to be situated in the district traversed by it. Some of these have been worked at different times. They are all magnetites.

Although high grade ore is obtainable from many of these deposits in south-eastern Ontario, they are of smaller size than those of the Lake Superior region and are thus to some extent handicapped. No doubt, however, now that the Province is becoming an iron producing country of importance these deposits will be the scene of considerable activity and the ores will always be in demand for special purposes. Only recently ores have been shipped from the Kingston district to Pennsylvania to be used in the production of high grade steel.

The smaller size of the deposits is partly compensated for by the fact that they are situated in districts in which labour and supplies are cheaper than in any other mining district in the Province. Moreover if methods were adopted in their handling such as were advocated by Dr. Douglas in his paper read before this Institute two years ago the output of merchantable ore could be greatly increased.

TITANIFEROUS MAGNETITES.

Before proceeding to a description of the newer ore fields I will refer briefly to the deposits of titaniferous magnetite which occur throughout the Province generally. These ores are of no economic importance at the present time although in the past material of this kind has been successfully smelted in other countries and the metal produced from it was of a high quality.

Numerous deposits of ore of this kind have been found in the Province from the area bordering the Rideau Canal, in the most eastern part, to the Rainy river district in the west, and they are often of large size. As is well known they are believed to be of a different origin from non-titaniferous ores and are classed among ore deposits of igneous origin. They are associated with basic rocks, gabbros, and are believed to represent basic secretions from molten magmas which were composed for the most part of material now making up the gabbros. The ore shades off gradually into the gabbro.

Some five or six years ago while investigating the composition of some of the dikes of eastern Ontario we found that they contained an unusually high percentage, for this kind of material, of nickel. As the

dikes possess a similar chemical composition to gabbros and are found in the same district as some of the titaniferous ores, it occurred to me that these ores should also contain nickel, if as believed they were of igneous origin. I therefore suggested to Mr. F. J. Pope who was then a post-graduate student at the School of Mining that he should test samples from a number of deposits for the presence of nickel. Mr. Pope undertook the work and found all the magnetites of this class examined by him to contain a small percentage of nickel. Afterwards he proceeded to Columbia University and while associated with Prof. Kemp he analyzed a number of samples of titaniferous ores from various deposits in New York state, all of which were found to be nickeliferous. Mr. Pope also found that the element vanadium is universally present in ores of this class, a fact of considerable interest bearing on the distribution of the rarer elements.

During the last few years Prof. Kemp has given considerable attention to the study of the titaniferous iron ores of New York state while those of Scandinavia have been studied by Prof. Brogger.

Mr. Rossi of New York has carried on detailed experiments with these ores in the blast furnace and has achieved results which he claims prove that the ores are of economic value as a source of iron and ferro-titanium.

If any important commercial use were found for the element titanium whereby it could be utilized as a by-product the ores would be in demand. Two or three years ago such a use was thought to have been discovered in dyeing and numerous enquiries were received in Canada concerning our supply of titaniferous ores.

The occurrence of nickel in these ores is of interest for two reasons. Since our nickeliferous deposits of Sudbury are thought to be of igneous origin the belief is confirmed that the nickel-bearing titaniferous deposits are of similar origin. Moreover the occurrence of this metal in these ores may explain the fact why the iron produced from them was of a high quality as regards strength and toughness.

These titaniferous magnetites are generally, if they contain much titanium, of a darker and duller color than ordinary magnetites and one familiar with their appearance can recognize them in hand specimens

and can thus avoid the expense of having them analysed. Moreover knowing their mode of occurrence with a certain class of igneous rocks the deposits can be distinguished in the field and can be thus put down as being of no present economic value and not worth any development work or expenditure for analysis.

THE NEWER ORE FIELDS.

The more recently discovered iron ore ranges in the northern and north-western parts of the Province occur widely extended in a region of great size.

The noted ranges of the United States practically surround the southern and western shores of Lake Superior, lying in the states adjacent. The ranges in Ontario which, so far as they have been examined, occur under similar geological conditions, have recently been found to occupy much of the territory bounding this great lake along its eastern and northern shores. The accompanying map shows that the Ontario ranges occupy a greater extent of territory than do those to the south and west of the lake and so far comparatively little systematic searching for iron ore ranges on this side of the line has been carried on. The location of these ranges has been discovered in most cases by accident, by prospectors and explorers who were engaged in other work.

The most striking characteristic of these ranges is the occurrence in them of bands of jasper or other closely related silicious material. This material usually occurs in the form of layers a few inches in breadth interbanded with iron ore which is in some cases hematite, in others magnetite.* When the jasper has a red color the interbanded material presents a remarkable and unique appearance.

The width of the belts of this interbanded material stretching across the country is often 600 feet or more. Some of the belts have been known to prospectors in Algoma and other parts of north-western Ontario for years but few of these men were acquainted with the iron ore districts to the south of Lake Superior and hence attached little economic importance to the outcrops, the iron being so intimately mixed with the silicious material as to be of too low a grade for mining.

* Figs 1 and 2.

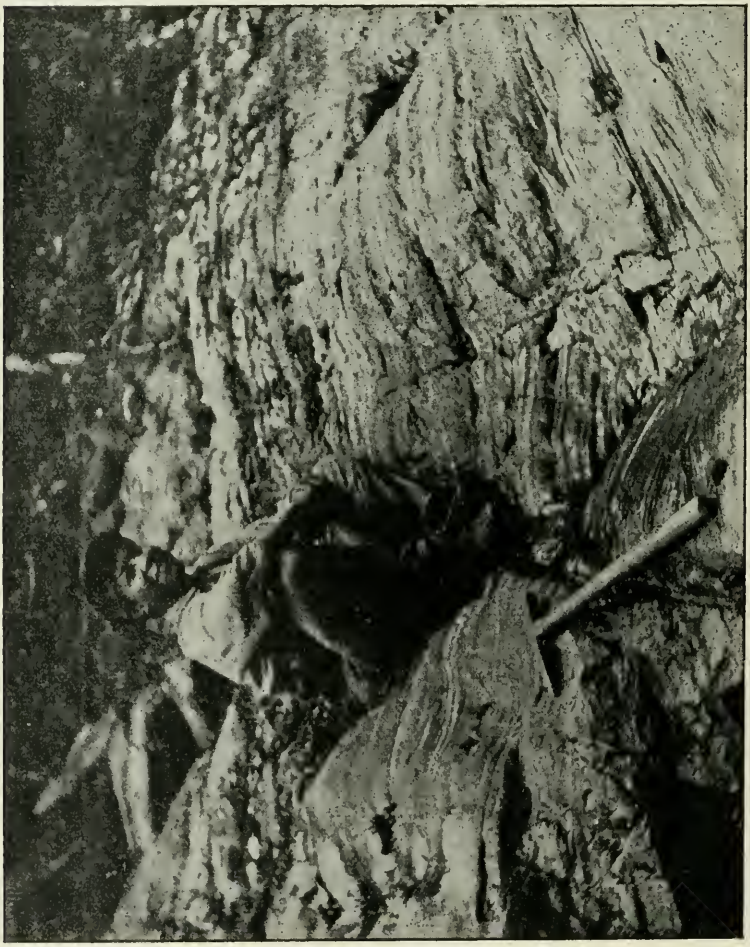


FIG. I.

Photo by W. G. Miller, 1900.

Interbanded Jasper and Magnetite, Iron Lake, vicinity of Lake Temegami.

Photo by W. G. Miller, 1900.

Interbanded Jasper and Magnetite, west side of Snake Lake, Nipissing District, Ont.

Some of the more silicious material when first found, during the gold excitements, was assayed for the precious metal but this being found to be absent no further attention was paid to the deposits. The fact was not known that under certain conditions, determined by the geological structure, ranges in which only lean ores are exposed at the surface are worthy of careful investigation.

In the states lying immediately to the south and west of Lake Superior the conditions of occurrence of workable deposits associated with leaner ores are now well understood. On some of the ranges in these states no ore deposits of value were found during the early explorations and the ranges were condemned. This is especially true in the history of the Mesabi range which has been proved to contain ore bodies of larger size than possibly any other part of the world. Although considerable work had been done on this range of a prospecting nature it was not till 25 years after it had first attracted attention as being possibly an ore area of value that workable deposits were discovered. Ore bodies were first opened up on this range in the early nineties and now the output of iron ore reaches an enormous number of tons annually.

The geological structure of the Mesabi range is somewhat different from that of most of our jasper-iron ranges. Those in this country appear to be more like the Marquette, Vermillion and others of the states adjacent to Lake Superior.

The history of some of these ranges has been, however, much like that of the Mesabi and it was only after a great deal of dead work was done on some of them that ore bodies of importance were found.

On the ranges last referred to it has been found that the ore bodies should be looked for in parts of the belt which have been disturbed by igneous intrusions. The most favourable structure seems to be where the jaspilyte, as it is called, or the interbanded jasper and hematite or magnetite, has been cut through by dikes of basic rocks.* In such cases ore bodies of great size are sometimes found resting upon the upper surface or hanging wall of the dikes. The theory is that the iron has been leached from the overlying rocks and carried in solution down to the

* Figs 10 and 11.

impervious layer formed by the dike matter and there deposited, replacing the silicious material. Detailed descriptions of the supposed origin of these ore bodies are given in the splendid monographs which have been published on the ranges of Michigan and Minnesota. The diagrams which I show are copied from some of these publications and give a good idea of the relations of the ore bodies to their associated rocks*. From these it will be seen that numerous ore deposits may underlie an area over the surface of which no ore of economic value is found among the rocks exposed. Great use is made of diamond drilling in determining these hidden deposits.

DISTRICT OF NIPISSING.

During the past season I spent some time on work for the Bureau of Mines in an examination of outcrops of jaspilyte which had been reported a few months before my visit as occurring in that part of the district of Nipissing lying west of Lake Temiscaming and stretching to the Algoma boundary.

As this is the only jaspilyte area that I have examined in any detail I shall give a brief description of it. The description will serve in a general way for the other known newer Ontario ranges all of which are of similar origin and character, and will apply in a general way to some of those to the south and west of Lake Superior.

Part of the district occupied by these iron ranges of Nipissing has been geologically surveyed by Dr. A. E. Barlow and I shall use his classification of the members of the Huronian system.

According to Dr. Barlow there are three series of fragmental rocks belonging to the Huronian of this district. The lowest of the three is composed of coarse fragments and is known as the breccia-conglomerate. Above this is a series mapped as graywacké and slate. Overlying this again is quartzite. Associated with this fragmental series are igneous rocks of various characters some of which cut through the different series while others are of older age.

The fragmental rocks appear to have at one time covered the most of the surface of this part of the district. They have however been worn down and are now found occupying more or less disconnected

* Fig 2.

areas in depressions of the underlying igneous masses. Hence the outcrops of jaspilyte although they form at times continuous bands some miles in length are disconnected and the jaspilyte range which we traced across Nipissing, between Lake Temiscaming and the Algoma boundary, is not continuous. Breaks occur in the range at places some miles in length. This is compensated for however by the fact that in some places there are two or more roughly parallel belts of jaspilyte. This is owing apparently to the series in which the jaspilyte occurs having originally been in a horizontal position. Afterwards it was folded. Since then the tops of the folds have been worn off and the jaspilyte bands as we now find them represent the legs of denuded anticlines and hence run in parallel positions.

Much of the jaspilyte is greatly bent and fractured and the cracks in it are filled in with quartz.

The jaspilyte is associated with the middle member of the Huronian, the graywacké and slate. This fact is of course of importance to prospectors; knowing in what member of the Huronian the jaspilyte occurs they will not waste time in searching for iron ore bodies among other members of the series.

A rather striking feature of the field is that a belt highly impregnated with pyrite and sometimes with pyrrhotite is found running parallel to the jaspilyte belt in almost every instance. Sometimes the pyritous belt is almost in contact with the jaspilyte, at other times it is a half mile or more distant.

The association of these two belts was of considerable assistance to us in our work of prospecting. This part of the district has received considerable attention from prospectors during the last few years as it appeared to be a continuation of the Sudbury nickel belt which lies to the south-west Consequently almost every rusty outcrop in the field examined by us had attracted the notice of nickel hunters and many of the outcrops had been stripped and had some blasting done on them. After we learned the relation which these rusty zones bear to the jaspilyte we had a key to the occurrence of the iron formation and by working off at right angles to the pyrite belt we were able to discover outcrops of jaspilyte.

It would appear as if some of the bodies of pyrite are of considerable size and they will be of economic importance as soon as a railroad is built into the district. Pyrite is now much in demand as a source of sulphur. In addition to sulphur, analyses which I had made show that the pyrite often contains other materials which will be of value as by-products. Gold values were found running from traces to $3.40 per ton, copper from 0.28 to 0 91 per cent., nickel from traces to 0.36 per cent. as well as traces of cobalt and in the cases of specimens from two outcrops traces of platinum were also found.

The map shows the position in a general way of the outcrops of jaspilyte we examined in the stretch of country running from a little west of Lake Temiscaming by way of Lake Temagami south-westward to the Algoma boundary. No bodies of soft ore or hematite were found associated with these outcrops but bodies of magnetite of considerable promise occur at some points. The discoveries of soft ore bodies outcropping at the surface are not numerous in other districts and this is not to be wondered at when we consider that they are much more easily worn down by agents of denudation than the harder magnetite and outcrops containing a higher percentage of rock matter.

If a number of ore bodies are not found in association with some of this jaspilyte the range will have to be considered to possess a unique character as no such great length of belts of similar character, in which no ore bodies of importance occur, are known in other districts. Of course considerable work may have to be done before the ore bodies are brought to light, just such work on has been done on some of the ranges of Michigan and Minnesota.

On beginning our work in the field we thought that the outcrops occurring in the vicinity of Lake Temagami were likely part of a belt running in a north-west direction as a jaspilyte band was found some years ago, during the survey of the boundary between the districts of Nipissing and Algoma, a little north of Shining Tree lake near the 61st mile post. As our work proceeded, however, we found that these Temagami outcrops form part of a belt which runs somewhat south of west and shows exposures of jaspilyte a short distance north of Lake Wahnapitae and in the township of Hutton on the boundary line.

Properly the outcrops in the neighborhood of Temagami should be said to form two or three roughly parallel bands. The nearest outcrop of jaspilyte to Lake Temiscaming, which here forms the boundary between Ontario and Quebec, so far discovered is situated on McDonald creek It is described as being of small size and I did not examine it.

Farther west numerous outcrops are found near the north shore of the north-east arm of Lake Temagami. A few miles north of this, exposures are found south-west of Net lake and along the shores of Vermillion and other lakes westward to the shores of Kokoko lake, a distance of about 10 miles. Some of these outcrops have a breadth of 600 feet or more and, from the relations which they bear to certain ignious intrusions, give promise of being of economic value.

A band of jaspilyte also runs in a direction somewhat south of east from Austin Bay the southern extremity of the south arm of Lake Temagami to Cross Lake. Westward this band extends to the islands lying along the eastern shore of the south-west arm of Temagami.

On Emerald lake 8 or 10 miles west of the last mentioned exposures jaspilyte is also found.

Further west again, as already stated, outcrops are found a short distance north of Lake Wahnapitae and in the township of Hutton which lies along the western boundary of the district of Nipissing.

Most of the exposures so far discovered are in the vicinity of easily accessible water courses. It seems likely therefore that other outcrops will be found in the intervening areas.

A sufficient number of outcrops has however been found along this strip of country between Lake Temiscaming and the Algoma boundary to form what may be called a more or less broken belt across the whole extent of this part of the district of Nipissing. It appears moreover that there is a belt of similar character across the district some 40 miles to the north. The reason for believing that a belt of jaspilyte occurs in that part of the district is owing to the fact that in addition to the outcrop near Shining Tree lake, on the western boundary, there are also outcrops on the Quinze river which lies in the Province of Quebec, some miles east of the eastern boundary of the district of Nipissing and about 80 miles almost directly east of the

Shining Tree outcrops. The area intervening between these two widely separated outcrops has not all been geologically mapped. The geology of the greater part of it is known however and the most of it is underlain by that member of the Huronian in which the jaspilyte is to be looked for.

Before turning from the description of the jaspilyte belts of Nipissing I may refer to the fact that the proposal has recently been made that the Ontario Government should construct a railway in the near future from North Bay station on the C. P. R. to the head of Lake Temiscaming. This proposal seems to have met with practically universal approval among financial and business men. Judging from the unanimity with which the proposal has been received it would appear that the district is assured of an outlet for its mineral and other products.

If this road is built by the Government as proposed its construction will inaugurate a new era of railroading in Ontario and I have no doubt that every mining man will welcome the change.

I have also understood that the building of a canal from the Georgian Bay, by way of the French river to North Bay is a live issue. If both the railway and canal are built these iron ranges of Nipissing will be better situated, so far as shipping facilities are concerned, than any of the great ranges whose outlet is Lake Superior. The ores from Nipissing after a comparatively short rail haul can be loaded on boats and reach Lake Huron without having to pass through the congested Sault canals.

ALGOMA DISTRICT.

I am not familiar from personal examination with the jaspilyte outcrops which have been found at numerous places in the district of Algoma but from the descriptions which have been published of them they seem to be similar in origin and in character generally to those of Nipissing. Some of these, those of Batchawana Bay and Michipicoton harbour, have been known for years but like many of our other mineral fields little attention has been paid to them till quite recently and systematic and careful work is now only beginning to be done on them. Already one ore body, described as being of great size, has been opened

up not far inland from Michipicoton harbour and I have not the least doubt that other great iron deposits exist in other parts of Algoma.

I am indebted to Dr. A. P. Coleman for an account of the general distribution of outcrops of jaspilyte and material of similar origin in Algoma so far as at present known.

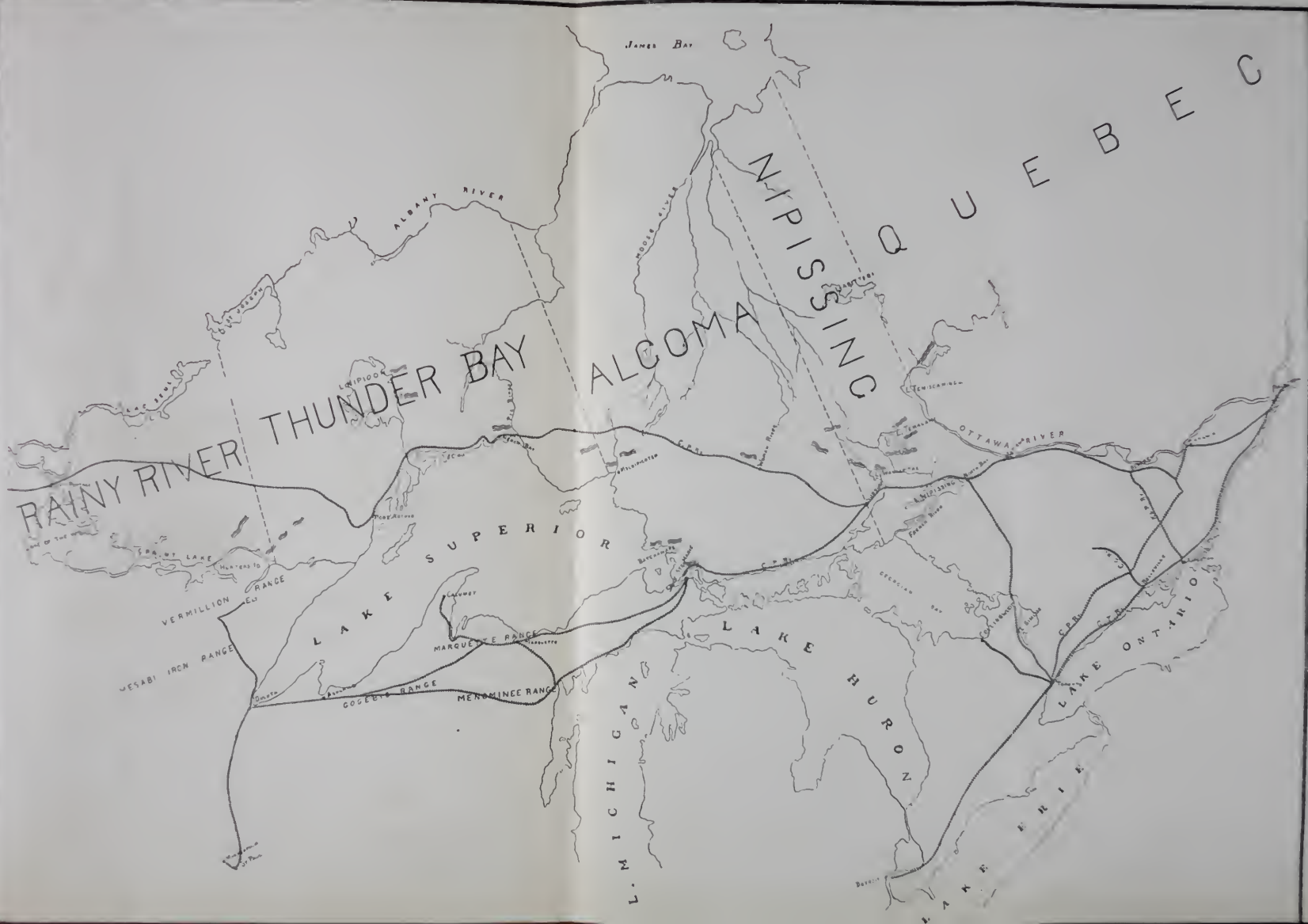
The map which accompanies this paper shows the relations which these outcrops in Algoma bear to each other and to those of the district of Nipissing.

I take the following outline descriptions of the belts in Algoma from a letter of Dr. Coleman. Referring in the beginning of his letter to those of Nipissing he states: "Similar bands have been found crossing Niven's line just north of Shining Tree lake, traced for about 3½ miles; and between Onaping and Meteor lakes, running somewhat east of south for a similar distance. One has been reported north of Woman river but was not visited by my party last summer, so we have nothing of it in detail. Then there is a Laurentian area and a wide gap. The next band of the sort is about 9 miles northeast of the "Soo" where cherty or quartzitic rock interbanded with magnetite is found but only in small amounts.

"North of Batchawana bay there are two bands each from 3 to 5 miles long, the southern one, 7 miles from the bay, of jasper with hematite running east and west; the northern one, 9 miles from the bay, is of cherty or quartzitic character with magnetite bands and runs north-easterly.

"The next point to the north is Gros Cap near Michipicoton harbor, where sandy and cherty rock is interbanded with hematite Twelve miles inland is the Helen mine, mainly of red hematite but mixed with "blue," brown and yellow ores, said to average about 58 per cent. of iron of fair quality though containing too much phosphorous to be of Bessemer grade. The deposit is stated to be 1,000 feet long from east to west and 400 feet wide with a proved thickness at one point of 288 feet. To the west of this rises a hill 450 feet high through which runs a belt of rather impure siderite perhaps 100 feet thick, probably the source of the ore.

"Then follows a gap to Eleanor lake where banded sandy layers


James Bay
ALBANY RIVER
MOOSE RIVER
RAINY RIVER
THUNDER BAY
ALGOMA
NIPISSING
QUEBEC
OTTAWA RIVER
LAKE SUPERIOR
LAKE HURON
LAKE ONTARIO
LAKE ERIE
L. MICHIGAN
VERMILLION RANGE
MESABI IRON RANGE
MARQUETTE RANGE
GOGEBIC RANGE
MENOMINEE RANGE

and iron ore occur. A few miles northeast probably the same belt crops out near Parks lake where a red hematite deposit said to be promising, is being explored. Some miles north of this a band of cherty and jaspery rock with magnetite occurs near Magpie river. The next important extensions of the range are near the head waters of Dog river at Paint lake where sandy magnetite occurs and a belt of similar rock parallel to it a few miles north, where a promising ore deposit is said to have been found by Prof. Willmott. These are east of Dog river, but the range extends to the west as jaspery iron ore for several miles, Iron lake being on the way."

THUNDER BAY AND RAINY RIVER DISTRICTS.

"The next point is near Pic river, north of Heron bay, where large masses of banded sandy rock and magnetite occur.

"Finally jasper banded with iron ore has been found east of Nipigon lake at two points some miles apart.

"Though these various stretches of silicious rock interbanded with iron ore differ a good deal in appearance they probably represent the same horizon. Up to the present the only large deposit proved to exist is the Helen mine, but two others, in the hands of the Clergues, are of promise and are being explored. So far as I am aware no other parts of the scattered iron ranges are being worked at seriously."

Dr. Coleman kindly placed this information at my disposal in answer to an inquiry made by me concerning the location more particularly of the recently discovered outcrops in Algoma and Thunder Bay districts. Hence he did not consider it necessary to refer to occurrences known to exist for a number of years in another part of the latter district. The deposits to which I refer form a belt which strikes from the Minnesota boundary north-eastward into the Thunder Bay district for a considerable distance. The deposits on this range which have attracted most attention include those situated in the vicinity of Hunter's island on the international boundary and others lying 30 or 40 miles to the north-eastward in the vicinity of Greenwater and Shebandowan lakes and farther eastward on what is known as the Mattawin iron range.

A part of the Canada Northern Railroad now being built from

Port Arthur to Winnipeg passes within a few miles of these more northern outcrops and thus encourages the opening up of the deposits. Up to the present little work has been done on this range on account of the lack of shipping facilities. During the past year, however the government diamond drill has been at work on the Mattawin and this and adjoining parts of the range are considered by those who have reported on them to be of a promising character.

This belt stretching from the international boundary is undoubtedly a continuation of the celebrated Minnesota ranges and it may be of interest to quote the opinions of United States geologists on the character of that part of the range lying in Canadian territory. The Messrs. Winchell in their Report on the Iron Ores of Minnesota make the following statement:* "Outside of Minnesota the belt of chloritic schist which carries ore passes into Canadian territory by entering Hunter's island. There is great probability of the existence of valuable deposits of iron ore on Hunter's island, and also further northeast in the direction of their strike."

There is also the Atikokan range which is now I believe being opened up on quite an extensive scale. The ore is said to be a rather coarse grained magnetite. This range lies in the Rainy River district near the line of the Canada Northern Railway.

SHIPPING FACILITIES.

It will be seen from the map that most of the Ontario ranges are as well situated as regards shipping via Lake Superior as are those which have already been developed on such a large scale to the south and west of this great lake. As regards the shipping facilities of the ranges of the district of Nipissing it is likely that in the future, as already pointed out, they will have an outlet via Lake Huron direct and will then be better situated than the Lake Superior ranges.

It may be well for comparative purposes to give the distances traversed and the rates charged per gross ton (2,240 pounds) from mines of the various United States ranges to ports of Lake Superior.

The following statement is taken from Vol. IV. of the final report of the Minnesota Geological Survey, p. 597.

* Bull. No. VI. Geol. and Nat. Hist. of Minn.

	Rate.
From Marquette range east of Republic and Michigamme to Escanaba, distance not over 65 miles.	$0.52
From Marquette range at Republic and Michigamme	0.67
From Marquette range to Marquette, 15 miles	0.32
" " " to Gladstone, 60 to 130 miles.	0.52
From Menominee range east of Mastodon to Escanaba, maximum distance 52 miles	0.40
From Menominee range west of Mastodon (Crystal Falls), distance 82 miles	0.43
From Gogebic range to Ashland, distance about 45 miles	0.40
From Gogebic range to Escanaba, distance about 184 miles	0.85
From Vermillion range to Two Harbors, distance 68 to 90 miles	1.00
From Mesabi range to Duluth and Superior, about 75 miles	0.80

The sailing distances and average ton rates for 10 years (1886 to 1895) are as follows :—

	Miles.	Contract Rate.	Wild Rate.
Marquette to Cleveland	583	$1.09	$1.12
Escanaba to "	523	0.91	0.915
Duluth to "	823	1.19	1.30
Ashland to "	774	1.19	1.30
Escanaba to Chicago	192	....	....

The average contract rates for 1895 and 1896 were :—

	1895.	1896.
Escanaba to lake Erie ports	$0.55	$0.70
Marquette to lake Erie ports	0.75	0.95
Ashland and Duluth to lake Erie ports	0.80	1.05

From the outline map which accompanies this paper it will be seen that the ranges of jaspilyte and related material are found over a greater extent of territory in Ontario than in the great iron producing States to the west and south of Lake Superior where the ore deposits, the largest known, are of similar origin and occur under the same conditions.

In conclusion, I may say, from what we now know of the iron ore fields of the Province we may feel that Ontario is assured of a great future as an iron ore producing country. Judging from the extent of territory over which the more newly discovered ranges have been found, Ontario should in the not far distant future take her place as one of the chief iron ore producers of the world.

APPENDIX.

SECRETARY'S REPORT.

(a) Upon the Work of the Institute.
(b) Reviewing Mining Progress in Canada during 1900.

MR. PRESIDENT AND GENTLEMEN:—

It is gratifying to be able to report the continued growth and prosperity of the Institute during the year.

MEMBERSHIP.

Notwithstanding a number of resignations, owing to members leaving the country and from other causes, our membership has increased to 323 (including fourteen student members) as compared with 277 in 1899 and 192 in 1898, when the Institute was reorganized under its present Constitution That the membership embraces the best elements in the profession and industry of mining in Canada may be seen by a reference to the recently published list of members; its wide distribution and thoroughly representative character is shown in the following comparative table:—

Province or Country	At 31st Dec., 1898	At 31st Dec., 1899	At 31st Dec., 1900
Nova Scotia	16	16	19
New Brunswick	2	1	2
Quebec	66	77	77
Ontario	44	68	91
British Columbia	42	65	71
Newfoundland		1	2
North West Territories	5	5	5
Great Britain	4	9	7
United States	11	17	26
China	..	1	..
Honolulu	..	1	1
Spain	..	1	2
S. Africa (serving with colors)	..	..	4
Alaska	..	..	1
Mexico	..	..	1
Students	2	15	14
Dead	2	4	6
Totals	192	277	323

It is also pleasing to observe that, while we lose a number of members by resignations going into force at this date, our strength will be considerably increased by the acquisition of the new members whose election to-day you will be asked to confirm.

Members Removed by Death.

We have again to deplore the loss of six members by death during the year :—

Mr. James King, of Quebec, was removed under particularly distressing circumstances, having been drowned early in the summer by a boating accident. By his death the Institute has lost one of its oldest and most valued members, a gentleman who took a lively interest in its affairs, and who had done much to advance the welfare of the mineral industry, particularly in his own native province, where he was prominently identified with the production of asbestos.

Dr. Carl Hoepfner, Hamilton, having only been a short time in the country, was not so well known, but he had achieved some reputation as a metallurgist and as the patentee of a number of processes for refining and treating nickel, zinc and other metals.

Mr. Ernest Bielenberg, of Greenwood, and Mr. Barclay Stephens, of Montreal, will be remembered as the promoters of a number of mining enterprises in British Columbia.

Mr. James Foley, Montreal, was the promoter and chairman of the Petroleum Oil Trust Limited, and other undertakings having for their object the Exploitation of the Gaspé Oil Fields.

And, gentlemen, I regret to say, no later than last week we have sustained a severe—I may say truly, a national loss, in the sudden and untimely demise of the honoured head of our Geological Survey, the late Dr. George Dawson, C.M.G., one of our Vice-Presidents, and a charter member of the Institute. As Dr. Ami will present a memoir of the late Dr. Dawson at a later session it will be unnecessary for me to refer here to the eminent services rendered by the deceased gentleman towards the development of the mineral and natural resources of the Dominion.

Members in South Africa.

Four members, Major Hamilton Merritt, Lieut. J. Edwards Leckie, Mr. Thomas Brown and Mr. L. H. Webber were absent from Canada serving the Empire with the colours in South Africa.

Meetings and Publications.

Our annual meetings were held as usual in Montreal during the first week in March and were exceedingly well attended, not only by local members, but by many mining men from distant sections of the Dominion.

The papers, discussions and business transacted have been fully published in the third volume of our Journal of Proceedings.

Five meetings of Council, and numerous meetings of Special Committees, have been held, and the attendance at all of these has been distinctly satisfactory.

Summer Excursion.

In August, the Institute had as its guests the American Institute of Mining Engineers and in conjunction and with the hearty co-operation of the officers and members of the Mining Society of Nova Scotia, we were enabled to carry out a most elaborate, interesting and highly enjoyable series of excursions through the most important mining and industrial sections of Eastern Canada and Newfoundland.

As the particulars of these excursions, meetings and entertainments will be fully described in the next volume of the Journal of the Institute, it will only be necessary to say that the chief points visited were Sherbrooke, Thetford Mines, Quebec, Sydney, Louisburg, the Bras D'Or Lakes, New Glasgow, Westville, Stellarton, Halifax, Waverley, Old Sydney Mines, St. John's, and the Bell Island red hematite mines in Newfoundland, and that at every point touched by the excursion the members and their guests were welcomed and entertained upon the most lavish scale.

The heavy costs of transportation involved in an excursion covering so vast a territory were met by a Grant of $2,000 from the Dominion Government, $500 contributed by the Mining Society of Nova Scotia (being half of an amount given to that organization by the

Government of Nova Scotia) and $250 from the Quebec Government. We were also indebted to the Intercolonial Railway, the Dominion Coal Co., and Mr. R. G. Reid of the Newfoundland Railway for special concessions.

Owing, however, to the impossibility of securing rolling stock in Canada, at that busy season of the year, we were compelled to bring the sleepers, dining car, and equipment comprising the Institute's special train from distant points in the United States, involving an expenditure for mileage which was not provided for in our estimates, and creating a small deficit which the Treasurer has been compelled to charge against the ordinary income of the Institute during the year.

The publication of a handsomely illustrated Souvenir Volume describing the mineral industries of the territory covered by the excursion was greatly appreciated by our guests, and although a large number of copies were printed in excess of the requirements of the party the demand for copies of it has been so great that we could easily have disposed of twice the quantity.

Legislation.

On 9th April, the Hon. Mr. Davis, Commissioner of Crown Lands, introduced in the Legislature of Ontario "An Act to Amend the Mines Act." Section 7 of this bill provided :—

> "Every person carrying on the business of mining for any of the said ores in this Province shall pay a tax upon the gross quantity of the ores or minerals mined, raised or won during the preceding year from any mine worked by him to be paid to the Treasurer of the Province for the use of the Province at the following rates, or such less rates as may be substituted by proclamation of the Lieutenant Governor, namely :—
>
> (*a*) For ores of iron, fifty cents per ton;
>
> (*b*) For ores of zinc, $5 per ton, or $15 per ton of metal contents if partly treated or reduced;
>
> (*c*) For ores of copper, $2 per ton, or $25 per ton of metal contents if partly treated or reduced;
>
> (*d*) For ores of nickel, $10 per ton, or $60 per ton, of metal contents if partly treated or reduced;

(*e*) For ores of copper and nickel, $7 per ton, or $20 and $50 respectively per ton of metal contents of copper and nickel if partly treated or reduced;

(*f*) For all other ores or minerals, such rate as may be from time to time imposed by Order-in-Council, but so as not to exceed five per cent. of the selling prices thereof in a free market."

The unwisdom of this proposed legislation will be readily appreciated by members of the Institute conversant with the conditions affecting mining undertakings; it imposed taxes absolutely ruinous and prohibitive; the very menace of them, if embodied in a statute, would be sufficient to destroy confidence and prevent investment.

Its unconstitutionality will be understood when it is stated that Section III of the 'Mines Act' of the Province had very distinctly repealed and exempted mineral lands patented prior to 4th May, 1891, from "all royalties, taxes or duties." In other words it was identical to the historic Mercier Mining Act which sought to confiscate mineral property in Quebec which had been alienated from the Crown unconditionally. Other provisions of the Bill were equally obnoxious.

The unexpected character of this proposed legislation, (it had passed its first reading in the Legislature before we became acquainted with its provisions), rendered immediate action imperative. There was no time to call the Council together, but in response to the urgent appeal of many of our members, whose interests were vitally affected by the Bill I went to Toronto and co-operated with a large body of Ontario mining men, in the effort to have the Bill withdrawn or modified. After many meetings and interviews, much lobbying, and a considerable expenditure of time, we were so far successful in having the Bill pass the Legislature greatly modified in its original provisions.

The special tax of 50 cents per ton on iron, $5.00 per ton (or $15.00 per ton of metal contents if partly treated or reduced) on zinc ores; $2.00 per ton (or $25.00 per ton of metal contents if partly treated or reduced) on copper ores; and the general tax on "all ores or minerals" at a rate to be fixed from time to time by Order-in-Council, not exceeding 5 per cent of the selling price were struck out; but the Legislature still reserves the right to impose a "license fee" of $10.00

per ton or (or $60.00 per ton if partly treated or reduced) of nickel; and $7.00 per ton (or $50.00 per ton if partly treated or reduced) on ores of copper and nickel.

The Act as adopted by the Legislature is still open to most grave objection on constitutional grounds and, if ever enforced, its legality will be tested in the Courts.

At a meeting of the Council held in Montreal on 9th July, my action in this matter was unanimously endorsed and the expenditure involved in connection with the work was approved.

Library and Reading Room.

The collection of works on mining and metallurgical practice, books of reference, exchanges from kindred societies, magazines and papers, maps, plans and photographs in the Library and Reading Room has been considerably extended during the year and an additional bookcase provided for their accommodation.

It has been suggested that in view of the comparatively limited accomodation provided for this collection in the Windsor Hotel, an endeavor should be made to secure larger premises elsewhere and there has been some correspondence with the Canadian Society of Civil Engineers with the object of ascertaining upon what terms the Institute might be given the use of a portion of their new building on Dorchester Street.

Other Business.

During the year the Secretary has replied to many enquiries asking for information concerning the mining industries of different sections of the Dominion.

MINING PROGRESS IN 1900.

Supplementing these notes on the work of the Institute it may not be inappropriate to refer to some of the salient features of mining enterprise and to the progress and prosperity of the mining industries of the Dominion during the past year. At this early date it is, of course, quite impossible to do more than make an approximate estimate, but from returns courteously furnished me by the managers and secretaries of our mining companies, by the officers of our Provincial

Mining Bureaus and other official sources, it is quite certain that we can congratulate ourselves upon the most successful year in the history of mining in Canada. A conservative estimate indicates that the value of our mineral output during the year 1900, when returns are finally completed, will be not less than $67,000,000 as compared with $47,275,512 in the year 1899.

Roughly speaking we may distribute the production as follows :—

Yukon, N. W. Territories and Manitoba...	$28,000,000
British Columbia	16,000,000
Ontario	9,288,424
Quebec	3,000,000
Nova Scotia and New Brunswick.....	11,000,000
Or in round figures	$67,288,424

[NOTE.—Since this report was presented, the Mines Section of the Geological Survey has issued a preliminary statement, subject to revision, estimating the mineral production of the year at $63,775,090, but, as quite a number of items, such as coal, iron and steel, nickel, asbestos, and mica, are manifestly under-estimated, I see no reason to alter my estimate.]

BRITISH COLUMBIA.

The statistics for the year are not quite complete but are sufficiently advanced to enable a very fair idea to be formed of the progress made last year which may be briefly summarized as follows :—

Tonnage ore mined	90%	increase.
Gold Production	20%	"
Silver "	35%	"
Copper	20%	"
Lead	200%	"
Output of Lode mines, values.....	50 to 60%	"

The statistics of coal have not yet been handed in and can only be estimated. The Vancouver Island Collieries are expected to have at least held their own, while the output from the Crow's Nest Pass has risen from about 69,000 tons in 1899 to over 230,000 tons in 1900 and this increase of 161,000 tons will about represent the increase in the total production.

For the following notes, I am indebted to the courtesy of Mr. W. F. Robertson, M.E., the Provincial Mineralogist :—

PLACER MINING.—Placer Mining proper has this year decreased very considerably. Atlin, our chief producer of last year, has been skimmed of the cream as far as the placers are concerned and is at present in the transition stage of shifting over to Hydraulics. Several hydraulic plants have been installed this past year but as yet, as might be expected, have not made any considerable output.

The ground in Atlin is, on the average, too deep for placer mining but is in many ways ideal for hydraulics and, with the values known to exist, should prove very profitable. The question of water will, however, be serious as there is not a sufficient supply to go round and consequently only a portion of the many leases can be worked at one time. The placer returns from the north central part of the Province are this year smaller than usual, owing to high water in the spring and the great demand for labour caused by the building of the telegraph line to Dawson.

HYDRAULICS.—The Cariboo District is showing that the diminished output of placer gold in recent years has not been due to the absence of that metal, simply to the fact that it lies too deep for placer work. It is now beginning to be recovered by the big hydraulic companies operating there, notably the Consolidated Cariboo Hydraulic Mining Co. which is further advanced in its work than any of the other companies. The output of gold from this district in 1900 will reach a point not touched for 14 years, certainly an encouraging sign. On the Coast a number of hydraulic leases have been taken out of beach deposits of black sand and the operations so far have yielded well, more than covering the costs of installation of plants and promising well for the future.

DREDGING.—The dredging problem has not yet been solved in British Columbia. The river bottoms have been proved to carry gold in quantity much greater than has been successfully worked in New Zealand and elsewhere, but the "conditions," viz: boulders and swift water, combined with the fineness of the gold, have yet to be successfully overcome; here is a tempting field for invention.

LODE MINING.—We have had our troubles of one sort and another, but 1900 will show a total production from the lode mines this year that will represent an increase of between 50 and 60 per cent. over

1899, while the tonnage of ore mined has increased over 90 per cent. showing that the lower grade propositions are beginning to be more generally worked, thanks to the gradually increasing transportation facilities.

LEAD.—The feature of the year is the increased lead production, which is over 200 per cent. higher than that of '99, and the fact that East Kootenay has this year carried off from the Slocan the banner as the chief lead mining district, producing nearly 60 per cent. of the total output of that metal.

SILVER.—An increase in the production of silver has naturally followed that of lead, as the two are so closely associated in British Columbia. This increase will be nearly 70 per cent. over '99, not as great as lead shows, for the reason that the silver contents of the East Kootenay galenas is not as high as those of the Slocan, which district has heretofore been our chief producer.

COPPER.—Copper will show an increase of nearly 20 per cent. over last year, due to the Boundary District becoming a producer. The production of this District would have further increased our percentage of gain had it not been offset by a falling off of the production of the Nelson District and the materially lower copper assay value of the Rossland Ores.

LODE GOLD.—The production of lode gold will show an increase of some 20 per cent. over 1899, due largely to the output of the Nelson District, which has been doubled this year, an increase tonnage in the Rossland Camp and the production of the Boundary District.

YUKON TERRITORY.

The output of gold from the Yukon during the year was not less than $25,000,000, as follows:—

Received Dust and Bullion, Government Assay Office Seattle.....	$16,946,437 08
Purchased by U. S. Mint and Selby Smelting Co., San Francisco during eleven months 1st Jan to Nov. 30th.	5,395,000 00
Add dust not reported and dust used in the territory, as a medium of exchange: say.....	3,000,000 00

The figures for previous years are: 1897 $2,500,000.00; 1898 $10,000,000.00 and in 1899 $17,500,000.00. The total sum collected by the Dominion Government up to 1st July, 1900 for Royalty on the gross output of placer claims, after deducting the exemption allowed by the regulations was $1,596,277.38. Of this amount the sum of $733,041.04 was collected during the fiscal year ended 30th June last, as follows :—

Dawson	$204,369 79
Grand Forks	24,462 49
Gold Run	49,036 95
Hunker Creek	40,113 90
Dominion Creek	94,749 06
Sulphur Creek	20,308 85
Total	$733,041 04

So far gold in payable quantities has been found in the bottoms of the valleys, or on terraces along the sides of these valleys. No rich quartz veins have been found, but it is in the highest degree probable that, where gold is found scattered in such abundance through the alluvial deposits, the veins or stringers from which it has been derived will be discovered, and that some of these veins or stringers, or aggregations of them, will be sufficiently rich to pay a profit over working expenses for extracting the gold.

Coal.—While the existence of the deposits of lignite in the Yukon Territory is well known, many of our members may not be aware that an effort has begun to exploit them commercially. As a matter of fact last season several thousand tons were mined and transported to Dawson, and 531 tons were exported, in September, to United States Territory.

One of the mines is operated by the Alaska Exploration Company on Rock Creek about seven miles from the point where it joins the Klondike river, and about twenty miles from Dawson. The seam averages from four to eight feet, being about six feet thick at a depth of 175 feet and is opened by a series of tunnels penetrating the seam for 400 feet in a direct line. Although but twenty-five miles from the centre of the mining district of Bonanza and Eldorado, and within ten

miles of Hunker Creek, the cost of transportation to these points and to Dawson has varied all the way from fifteen to twenty-five dollars per ton. With the opening up of the country these costs of course will be very greatly reduced.

The other working mine is operated by the North American Trading and Transportation Company, on Cliff Creek, which enters the Yukon sixty miles below Dawson, and ten miles below Forty Mile Creek. It is situated a mile and a half up the Creek and is connected with the Yukon by a tram line over which the coal is delivered into the bunkers on the company's wharf and then loaded into river steamers for delivery at points on the Yukon river. The seam is reported to be eight feet thick and is opened by four tunnels, the shortest of which is 200 feet and the longest 450 feet. Last season the mine produced 3,000 tons, the whole of which found a ready market.

Dredging in the Yukon and North West Territories.

During the fiscal year ended 30th June last, leases have been granted by the Dominion Government to dredge for minerals in the Yukon Territory covering 1,313 miles and for the same purpose in the North West Territories covering 961.75 miles. Gold dredging on the North Saskatchewan River is still in an experimental stage.

During the past season the large dredge of the Saskatchewan Gold and Platinum Proprietary Limited has only been in partial operation —owing to the necessity of making certain necessary changes in the machinery. When, after many delays, due to the late arrival of the machinery from England, the dredge was put into commission, it is understood, though not yet officially announced, that the result was highly satisfactory showing a saving of from 25 cents to 30 cents per cubic yard.

The Saskatchewan Gold and Platinum Proprietary and the Alberta Gold Dredging Co. Ltd., have each a dredge approaching completion so that there will be three ladder bucket dredges at work on the river during the coming season. The dredges of the Loveland Co., the Evans Co., and one or two other concerns worked profitably during the year, but have only a limited capacity and are merely "dipper" dredges. As these are private enterprises they do not issue

statements of results. The Star Gold Dredging Co., Ltd., contemplates building a large dredge of the New Zealand type.

To those of our members who are engaged in this industry, the following figures showing the profits realized last year from gold dredging operations in New Zealand will be of interest :—

"During the month of October ten dredges in Otago paid in dividends the sum of £8,135 while the dividends declared and paid by twenty-seven working Otago dredges for nine months, from January 1st to September 30th, 1900, are £76,118 on a capital of £195,652 which gives a return equal to 39 per cent. for nine months only. From January 1st to November 20th, 1900 there has been gained 56,533 oz. 8 dwt. 3 gr., which, at 77 s. per oz., is equal (roughly) to £217,625. For forty-six weeks the average number of working dredges has been thirty-four. The working expenses of each one, at £50 per week, are equal to £1,700. The weekly profit so far has equalled £3,031 (approx.). There were, at the end of October, thirteen dredges with a capital of £97,500, working, which so far this year (1900) have not paid any dividends. The amount invested in working dredges equals : Paying dividends £195,652, not paying dividends £97,500; total, £293,152. Taking declared dividends £76,118 to capital of all working dredges, £293,152 the return for nine months only is equal to 26 per cent."

ALBERTA.

The output of coal in the territories during the year was : Bituminous coal 304,000 tons ; Anthracite coal 17 500. There was a slight falling off in production at Lethbridge the output of the Alberta Railway and Coal Company being 181,801 tons as compared with 192,889 tons in 1899. The H. W. McNeill Company also report a decline in the output of their collieries the production for the year being : Canmore Colliery 80,000 tons ; Anthracite Colliery 18,000 tons.

It is not unlikely that before another year has passed the railway from Lethbridge to Great Falls will be made to standard gauge, in which case it is probable a large export trade of this Anthracite coal will be built up with Montana, Northern Idaho and Eastern Washing-

ton. The formation of a number of new companies indicates a probability of a very considerable development in the near future of the coal fields of Alberta along or near the line of the Crow's Nest Pass Railway.

ASSINIBOIA.

The production of Lignite at Roche Percee and Coal Fields will show an increase over previous years. As the workings extend the quality of the coal is found to improve and its sale is rapidly extending among the settlers of this Province and in South Western Manitoba.

MANITOBA.

A large number of mining claims have been recorded during the year in the district lying adjacent to the western boundary of the Province of Ontario, and several gold mining properties are being opened up. The gypsum deposits situated in the district lying north of Lake St. Martin in Townships 32 and 33, Ranges 8 and 9 West, are being rapidly staked out. The Manitoba Union Mining Company, composed of Canadian and American capitalists, have staked out a large area of land valuable for this commodity and purpose developing the claims at an early date. It is their present intention to place a reduction mill at Portage Bay on Lake Manitoba and to construct a tramway from that place to the mines.

Coal Markets in Manitoba and North West Territories.

The Crown timber agent at Winnipeg has furnished the following statement of the consumption of coal at points in Manitoba and as far west as Regina, which can be taken as approximately correct :—

American Anthracite	32,700	tons.
Canadian "	11,000	"
American soft	3,500	"
Canadian Galt	9,500	"
Souris Lignite	34,000	"

The following prices were obtained during the years 1899 and 1900, as shown hereunder :—

	1899 Per ton.	1900 Per ton.
American Anthracite, f. o. b. at Winnipeg...	$7 75	$9 50
Canadian " " " " ...	6 75	9 00
American soft, f. o. b. at Winnipeg.....	6 00	7 00
Canadian Galt, " " "	.....	7 50
" Souris, " " Souris	3 75	3 75
Souris Lignite, " " Brandon.....	3 20	3 20
" " " " Regina.....	3 20	3 30
" " " " Melita.....	2 75	2 60
" " " " Moosejaw.....	3 00	3 10

ONTARIO.

Gratifying progress marked the year's operations in Ontario the total value of the mineral production being estimated at $9,288,424 as compared with $8,789,901 in 1899.

Copper and Nickel.—The feature of the year was unquestionably the notable expansion of the copper and nickel mining and smelting industries which have now assumed a leading position among the metalliferous mining enterprises of the Dominion.

Fifteen years ago when the members of the Canadian Copper Company pluckily invested their capital and commenced their pioneer work of development in the region, Sudbury was a barren and inhospitable region. To-day, owing to mining, and entirely dependent on it, it has grown to be a prosperous community, having a population in excess of 6,000 people, well housed, having excellent churches and schools, a good electric lighting system, a well managed hospital and a water works and drainage system equal to the demands of the people. 1,500 persons, miners, mechanics, furnace men, labourers, teamsters, etc. find employment at the mines. One company has spent in the district no less a sum than $2,774,000 in wages and over $4,000,000 in machinery, tools and supplies purchased in Canada and freights over Canadian railways. Add to these the very large sums expended during the year past by the Mond Nickel Company, the Canada Mining & Metallurgical Company, and other operators in this region and one realizes the vast importance of this great industry not only to the Province of Ontario but to the whole Dominion.

It has been stated by those interested parties who, to benefit themselves and their schemes, have been clamouring for the imposition of export duties, and other foolish taxation on these ores, that at present Canada is receiving less than 28% of the market value of the metal contents of this production. What are the facts? During the year 1900 there were produced from the mines at Sudbury 21,518 tons of copper nickel matte, in the production of which $1,050,000 were expended on Canadian labour and supplies, or an amount equivalent to 72 per cent. of the selling price of these metals. It may be further stated that large concentrating works are now nearing completion at Copper Cliff, whereby the percentage of values of the metals remaining in Canada will be further increased to 85 per cent. or 90 per cent. of their market value. These works are expected to be in operation by the 1st of May this year.

Among the year's additions to the list of active producers in this industry may be mentioned the extensive new works of the Mond Nickel Company at Whitefish, the operations of the Canada Mining and Metallurgical Company at Massey, the Bruce Copper Mines of Ontario, Ltd., re-opening and erecting an important concentrating plant at Bruce Mines, on the north shore of Lake Huron, and the Rock Lake Mining Company, in the same vicinity. Nor must we overlook the opening up of the Gertrude Nickel property in the township of Creighton by Mr. F. H. Clergue and his associates, for it is from this mine that they propose to draw the supplies of nickel for the manufacture of ferro-nickel and nickel steel at their large establishment now under construction at Sault Ste. Marie. The Frasch process for refining nickel and other metals, about which certain Hamilton promoters were so enthusiastic a year ago does not appear to have materialized, beyond the stage of laboratory experiment.

Iron.—The magnetite mines of Eastern Ontario have been pumped out and overhauled, and a number of them have been producing and shipping ore, some of which went to the blast furnaces at Hamilton and the remainder to smelters south of the line. The production of Iron Ore in Ontario was 16,911 tons, a very large increase over the previous year, mainly due to the opening up of the Helen hematite mine in Michpicoton by The Lake Superior Power Company.

The body of ore in the Helen mine is a very large one, doubtless containing many millions of tons, and the quality is good, though non-bessemer, running pretty uniformly about 55 or 57 per cent. of metallic iron. The bulk of the output for 1900 was carried by steamer to the new blast furnace built by the Canada Iron Furnace Company at Midland, and blown in December last. A sample cargo was sent to Ashtabula, and Mr. Clergue is credited with the intention of entering into competition with the mines of the Messabi and Vermillion ranges in supplying the furnaces of Cleveland and Pittsburg, in spite of the duty of 40 cents per ton. The Helen mine was discovered in 1897 and but little work done on it until after it passed into Mr. Clergue's hands in 1898. Since that time a railway twelve miles long has been built, ore docks constructed, steamers brought from England to carry the ore, and next season will probably see half a million tons taken from the mine. The Midland Furnace makes the third in operation in the Province, the other two being at Hamilton and Deseronto. At both Hamilton and Deseronto, the ores used have been chiefly from the American side of Lake Superior but since an abundant supply of equally good ore has been uncovered at Michipicoton, it is quite probable the wants of the furnaces will be supplied from our own Province. New blast furnaces are being projected at Collingwood and Kingston.

I am indebted to the Director of the Bureau of Mines for the following statistics :—

		1900	1899	1898
Ore Smelted...	tons	100,692	110,036	77,023
Scale and mill cinder.	"	13,092	10,004	8,614
Limestone for flux....	"	.....	25,301	13,799
Coke for fuel.....	"	59,345	74,403	50,407
Pig Iron Product.....	"	62,386	64,749	48,253
Value of Product.	$	936,066	808,157	530,789
Wages for Labor.....	"	97,915	79,869	61,476
Average workmen....	No.	419	200	130

Gold Mining.—The past year has witnessed a complete collapse in the production of gold in the north western section of the Province and most of the mines in the Lake of the Woods and Rainy River dis-

tricts from which, a year or two ago, so much was expected, are shut down. It can be safely said that this failure is due neither to lack of good properties nor to lack of capital to exploit them. Over capitalization, ten cent stock manipulations, the greediness of promoters, unskilful labour, and, perhaps more than any other, grossly incompetent management are prominent factors which have brought about this unfortunate and deplorable depression.

In contrast to the falling off in production in the North-Western sections of the Province it is gratifying to note the activity in the development of gold mining enterprise in Eastern Ontario.

The Deloro mines, in Marmora township, Hastings County, operated by the Canadian Gold Fields Limited, have made sound progress both in the establishment of a successful plant for gold extraction and in under-ground development. It is worthy of remark that about 40 tons per month of White Arsenic, quite equal to the best English and German grades, is being produced by this company as a bye-product. 125 persons are employed. Extensive mining and milling operations are also being conducted by the Cordova Exploration Company, Limited, another English Company, at the Belmont mine, in Peterborough County. This company employs 130 men. The Atlas Arsenic Company, the Sophia, and other properties, are also being worked in this section.

Graphite.—This mineral is being mined profitably, and on a fairly large scale, in the township of Brougham, Renfrew County, by the Ontario Graphite Company, the output realizing a good price from consumers in the United States.

Other Minerals.—The output of zinc, mica, petroleum, natural gas, silver, pyrites and structural materials also contributed to what has been on the whole, a year of substantial progress in mineral production in Ontario.

Statistics.—Mr. T. W. Gibson, Director of Mines for Ontario has courteously furnished the following official statement of the mineral production of the Province during the year :—

The total value of the mineral output of Ontario for 1900 was $9,288,424; the number of workmen employed in the industry 11,109

and the amount of wages paid $3,364,400. Following are some of the principal items:—

	Quantity.	Value.
Building stone		$ 650,342
Cement ..... barrels.	432,154	698,015
Lime ..... bushels.	3,893,000	544,000
Drain Tile ..... No.	19,544,000	209,738
Brick & Terra Cotta... No.	254,701,600	1,520,959
Petroleum ..... Gallons.	23,381,783	1,869,045*
Natural Gas		392,823
Salt ..... tons.	66,588	324,477
Mica ..... "	609	81,550
Iron Ore ..... "	90,302	111,805
Pig Iron ..... "	62,386	936,066
Steel (open hearth)... "	2,819	46,380
Nickel ..... "	3,540	756,626
Copper ..... "	3,364	319,681
Gold ..... ounces.	18,767	297,861
Silver ..... "	160,612	96,367

* Value of Products, viz., illuminating oil, lubricating oil, etc., *not* value of Crude.

PROVINCE OF QUEBEC.

Asbestos.—Mining in this Province was chiefly remarkable for the flourishing condition of the Asbestos industry. A strong market and a considerable advance in prices for all grades of fibre created an activity at the mines in the Eastern Townships unprecedented in the history of Asbestos production in Canada. Properties which had been shut down for years were reopened, large expenditures were made in re-equipment, expensive modern milling plants were installed, or are under construction, and, notwithstanding an advance of 25 per cent. in wages the labour market was, and is still, inadequate to the requirements of the industry.

From returns furnished by the mines and railway companies the shipments from Thetford, Black Lake, East Broughton, Ottawa County and Danville, during 1900, will approximate in round figures 23,251

tons of all grades of asbestos, and nearly 7,000 tons of asbestic, estimated on the most conservative basis, to be of a value at the mines of not less than $1,000,000. The shipments over the Quebec Central Railway increased from 13,898 $\frac{1490}{2000}$ tons in 1899 to 19,970 $\frac{265}{2000}$ last year, as follows:—

From Thetford Mines	31,254,700 lbs.
" Black Lake	6,896,565 lbs.
" East Broughton	1,789,000 lbs.
Total shipments via Quebec Central Ry.	39,940,265 lbs.

During the year 1899, if we may believe the returns published by the Mines Section of the Geological Survey, the production was valued at $483,299.

Iron.—The iron industry will also, we believe, show increased values over previous years. Charcoal pig iron of superior quality was manufactured by the Canada Iron Furnace Company, at Radnor Forges, and by the Grantham Iron Works, at Drummondville. The figures of the Canada Iron Furnace Company were:—

Pig Iron made	4,677 $\frac{1880}{2240}$	tons.
Ore charged	13,019	"
Charcoal used	660,000	bushels.
Limestone	1,550	tons.

The returns from the MacDougall Plant are not available. 2175 tons of magnetite were shipped to the United States from the township of Hull. It is not unlikely that the Bristol Iron Mines, in Pontiac County, will be reopened again this year, and there is a movement in progress to exploit the large deposits of the magnetic sands on the North shore of the St. Lawrence.

Mica.—During the first six months of the year mica mining was actively prosecuted principally in Ottawa County, in the districts of Templeton, Wakefield, Hull and Buckingham and record prices ruled for all sizes and grades. Towards the end of the year, however, a reaction set in, the market weakened, and production fell off considerably.

Hitherto the bulk of Canadian Mica has found a ready market in the United States where it is greatly favored for electric insulation, and while this is the most natural outlet for our production, there seems to be no reason why a very much larger trade should not be built up with the United Kingdom and the continent where, hitherto, Indian Ruby Mica, from Madras and Bengal, have practically had a monopoly of these markets.

A glance at the statistics given in the following table, courteously furnished by Mr. Harrison Watson, Curator of the Canadian Section of the Imperial Institute will be useful in this connection.

	Quantities. Cwts.	Value. £	Quantities. Cwts.	Value. £	Quantities. Cwts.	Value. £
Norway	....	....	....	....	....	....
Germany	184	1.104	541	1.572	60	538
Holland	4	67	58	77	32	302
Belgium	249	2.395	456	666	95	625
French Possnin India	....	....	....	....	....	....
China	....	....	....	....	....	....
United States	3.442	4.745	10,028	7.550	2353	2916
Brazil	40	544	102	397	417	2455
Uruguay	....	....	....	....	43	250
Argentine Repub.	69	245	62	491	....	....
Bombay	14	120	79	602	70	615
Madras	4086	31364	4,750	33,497	16,136	93,773
Bengal	6171	37796	12,301	69 589	17,156	81,130
Burmah	....	....	4	45	....	....
Ceylon	148	1094	132	932	237	1,440
Hong Kong	....	....	....	....	20	25
South Australia	18	115	....	....	....	....
Victoria	12	95	....	....	....	....
Canada	103	790	200	845	962	4,199
Newfoundland	....	....	71	220	....	....

The late Dr. George Dawson having sent over to London average samples of Canadian Mica with the object of determining their commercial quality and the likelihood of an extension of trade in the United Kingdom, Prof. Wyndham Dunstan, M.A., F.R.S., Director of the Scientific and Technical Department of the Imperial Institute reports as follows :—

"General physical and chemical examination showed that the samples were uniform in character, pliable and softer than much of the mica which appears in the English market.

In order to ascertain its commercial value, and especially its fitness for electrical purposes, the samples were submitted to one of the largest electrical manufacturers in London, and also to one of the largest mica brokers in the City.

The electrical manufacturers report that the mica is suitable for a variety of electrical purposes. On the general question of the uses and comparative value of the Canadian Amber Mica, the brokers remark that this variety of mica is of no other value than for electrical purposes, its special value being principally due to its softness and easy lamination. They are of opinion that Canadian amber mica is of greater value for electrical work than most of the Indian mica that comes to this country. They remark, however, that there are two or three varieties of Indian Mica, such as White Bengal, Cochin, from the west coast of Madras and Ceylon Amber Mica which compare very favourably with the Canadian product, whilst the selling prices of these Indian varieties are often from one third to one half those asked for the Canadian Mica. They confirm the opinions expressed in Dr. Dawson's letters of February 16th and April 4th of this year, that Canadian miners obtain a better price in the United States than in the London market chiefly from the circumstance that American electricians prefer the Canadian product which is close at hand and can be depended upon for uniformity of quality and regularity of supply.

Although circumstances point to the United States as being the natural outlet for Canadian mica, nevertheless it would be worth while to take steps to make it better known in the British market since there are several factors operating against the Indian product, especially in the matters of tariff and regularity of supply."

It may also be of interest to those of our members who are engaged in this industry to learn that during the year ended 30th

March, 1900, 22,599 cwt. of mica was exported from India, of which the United Kingdom took 18,569 cwt.; France 33 cwt.; Germany 250 cwt.; United States 3,666 cwt.; Ceylon 30 cwt.; and Japan 51 cwt.

Returns for the United States are not yet available for last year, but we may quote those published by the Director of the Division of Mineral Statistics at Washington for the year 1899 in the hope that they may be useful for reference:—

1899.	Quantity.	Value.
Unmanufactured	1,709,839	233,446
Cut or trimmed	67,293	42,538
Total	1,777,132	275,984

Chromite.—Returns from the Quebec Central Railway show that the shipments of this mineral were: From Black Lake 4,117,840 lbs. and from Coleraine 555,860 lbs. or a total of 2,336 $\frac{17}{20}\frac{0}{0}\frac{0}{0}$ tons. The output for the previous year, as reported by the Geological Survey was 1,980 tons of a value $23,760.

It is worthy of remark that a portion of the output was shipped to the Electrical Reduction Works at Buckingham, Que. for the manufacture of ferro-chrome.

Copper Pyrites.—Production, as in former years, was confined to the old established and extensively worked mines of the Eustis Mining Company at Eustis, and the Nichols Chemical Company at Capelton. Some prospecting was also done in the neighborhood of Sherbrooke.

Gold Mining.—Attention has been again directed towards the exploitation of the Beauce Gold Fields and some exploration work is being carried on by the Beauce Syndicate Limited, an English Company, over the property of the McArthur estate.

Lead.—During the year, the old Wright mine, at Lake Temiscamingue, was acquired by the Anglo-Canadian Lead Syndicate Limited, an English Company, having an authorized capital of £21,500, of which £13,437 10s. is paid up. The mine has been reopened and is being re-equipped with new machinery, including a concentrating plant brought out from South Wales. Several hundred

tons of ore and concentrates were shipped to England during the year, one cargo assaying :—

Bullion Lead in concentrates..... 63.5 per cent.
Silver per ton of cencentrates..... 14.87 ounces.

Other Minerals.—Barytes, ochre and structural materials constituted other features of the mineral production in this Province. It is greatly to be regretted that a highly successful year should be marred by the inevitable and long looked for collapse of the so-called Gaspé Oil Fields, and the consequent liquidation of the Canada Petroleum Company. While it is possible an effort will be made to reconstruct and consolidate the various companies which have spent with a lavish hand so much British Capital in the exploration of this territory, the outlook does not warrant any expectation of success.

Value of Total Output.—From these facts I should say that the value of the mineral production of the Province of Quebec will not be less than $3,000,000, as compared with a valuation of $2,000,000 in the previous year.

NEW BRUNSWICK.

The production of Manganese and Gypsum constituted the most important features of the somewhat limited mining enterprise in this Province.

The Mineral Products Company, at Hillsboro, we believe, are now figuring on the construction of a ferro-manganese plant in the Province.

Coal Mining, in Albert and Queen's County, it is reported, will be exploited on an important scale during the ensuing year.

NOVA SCOTIA.

Entering, as they unquestionably are, upon an era of great activity, the coal, iron, and steel industries of Nova Scotia occupy a foremost position in the mineral expansion of the year.

The returns published by the Government are made up for the fiscal year which ends on the 30th September.

Coal.—The output of coal during this period was the largest in the history of this industry, amounting to 3,238,245 tons as compared

with 2,642,333 tons in the previous year, and the sales 2,997,546 tons compared with 2,419,137 tons in 1899. The most notable shipments were 624,273 tons to the United States, the greatest on record to this market, the largest previous shipments being 465,194 tons to 1865.

New collieries were opened out and are being equipped at Port Morien, by the Gowrie and Block House Collieries, Ltd., at Port Hood, by the Port Hood Coal Co., and, at Broad Cove, by the Inverness and Richmond Collieries and Railway Co., Ltd. In addition to these important additions to the list of producers, the Dominion Coal Company has three new collieries under development which will materially add to their output during 1901.

A feature of the year was the passing away of the historic General Mining Association, Limited, the pioneer of mineral development in Nova Scotia, which sold the remainder of its once vast mineral holdings to the Nova Scotia Steel Company. The new owners are building an up-to-date coking plant at Old Sydney Mines to supply their furnace plant at Ferrona, in Pictou County, and as a feature of their contemplated large steel works.

The following table shows the output and sales by companies during the fiscal year :—

COMPANIES.	Output.	Sales.	Colliery Consumption & Workingmen.
	TONS.	TONS.	TONS.
Acadia Coal Co	294,884	258,378	37,581
Canada Coals and R'y. Co	67,290	55,456	8,621
Cape Breton Coal Co	12,426	9,891	2,535
Cumberland Ry. & Coal Co	428,904	403,170	25,723
Dominion Coal Co	1,930,425	1,808,694	88,041
Gowrie & Blockhouse	Being opened.		.....
Intercolonial Coal	244,000	226,535	17,484
Inverness & Richmond	56	Being opened.	
Jubilee Colliery	85	58	27
Mabou Colliery	195	65	.....
Nova Scotia Steel Co	249,910	225,932	28,033
Port Hood Coal Co	2,323	1,770	522
Scotia Colliery	525	417	58
Sydney Coal Co	7,222	7,180	457
Total	3,238,245	2,997,546	209,082

Iron and Steel.—The vast undertakings of the Dominion Iron and Steel Company are well known to all of you. The furnaces and coking plant have practically been completed, and the steel works are rapidly being constructed. The operation of this great establishment means a greatly extended consumption of coal during the present year, and we trust for many years to come. During 1900 the Company imported from their mine at Bell Island, Newfoundland, about 100,000 tons of hematite.

The Nova Scotia Steel Company mined about 1,600 tons from their Bridgeville areas. The operations of this progressive company will be readily understood from the following figures :—

Nova Scotia Ore used at Ferrona.....	19,000 tons
Wabana hematite (Newfoundland).....	33,000 ,,
Other foreign ore consumed.....	2,000 ,,
Limestone quarried.....	27,500 ,,
Coke made.....	29,000 ,,
Pig iron made.....	29,260 ,,
Steel made.....	22,000 ,,

Considerable activity was also manifested in the prospecting and exploration of iron areas at Torbrook, in Annapolis County, at Arisaig, in Antigonish County, and at Whycocomagh, in Inverness County, which it is hoped may ultimately lead to the discovery of workable deposits.

Gold Mining.—The output of gold was slightly in advance of previous years, the returns for the fiscal year (ended 30th September), showing a yield of 31,110 ounces compared with 27,772 ounces in 1899.

The crushings amounted to 65,000 tons so that the average yield was about half an ounce to the ton. The Brookfield Mining Company, Blue Nose Gold Mining Co., and Richardson Gold Mining Co., were, as usual, the most profitably worked undertakings.

At Harrigan Cove 1813 tons yielded 3,403 ounces.

Copper.—A copper reduction plant was completed at Pictou by the Copper Crown Mining Company, and several hundred tons mined at their properties in Colchester and Cumberland. Deposits at Polson's Lake and Lochaber, in Antigonish Country, were also prospected.

Gypsum.—Gypsum returns so far show that the year's production was slightly behind last season's, due largely to the non-working of the quarries in the Baddeck Disrrict. It is expected that these quarries will resume work next year, and that the production will rise from 122,281 tons to its normal figure of about 150,000 tons. In addition to the shipments of this mineral, considerable quantities are manufactured for local use, ground for house work, and used in the manufacture of fertilizers.

Other Minerals.—783 tons of Barytes were produced from Cap Rouge, Inverness County.

Tripoli and Silica.—Incomplete returns show that about 1,150 tons were treated, chiefly by the St. Ann's and by the Bass River Silica Companies.

In addition to the usual quantities used locally, the Nova Scotia Steel Co. quarried 24,300 tons of limestone, and the Dominion Iron and Steel Company used a large quantity for concrete work taken from their Georges River Quarry, probably about 75,000 tons. In addition large quantities are being quarried at that place and at Marble Mountain, West Bay, for the company's furnaces.

BOUNTIES PAID IN 1900.

The Auditor-General's Report for the year ended 30th June last shows the following bounties paid on pig iron, puddled bars, steel ingots, and silver:—

Bounty on Pig Iron.

CANADA IRON FURNACE CO. ($18,234.92).—

Production during 12 months ended June 30th, 1900—

6052.78 tons from Canada ore @ $3.00	$18,158.34
38.29 tons from foreign ore @ $2	76.58

DESERONTO IRON CO. ($27,026).—

Production during 12 months ended April 30th, 1900—

462 tons from Canada ore @ $3	1,386.00
12,820 tons from foreign ore @ $2	25,640.00

HAMILTON BLAST CO., Ltd. ($107,009,69).—

Production during 12 months ended May 31st, 1900—

11,929.19 tons from Canada ore @ $3	35,787.57
35,611.06 tons from foreign ore @ $2	71,222.12

JOHN MCDOUGALL & CO. ($5,485.07).—
(Grantham Iron Works).
Production during 10 months ended April 30th, 1900—
1,828.37 tons from Canada ore @ $3 ..... 5 485.07

NOVA SCOTIA STEEL CO. ($73,162.22).—
Production during 12 months ended May 31st, 1900—
11,886,225 tons from Canada ore @ $3 ..... 35,658.67
18,751.77 tons from foreign ore @ $1 ..... 37,503.55

MINERAL PRODUCTS CO., PICTOU ($7,378.24).—
Production during 5 months ended Nov. 30th, 1900—
2,459,415 tons from Canada ore @ $3 ..... 7,378.24

$238,296.14

Bounty on Puddled Iron Bars.

ONTARIO ROLLING MILLS CO.—
Production during June, 1899, from pig iron made in Canada—
400,165 tons @ $3 ..... 1,200.50

HAMILTON STEEL & IRON CO., LTD.—
Production during 11 months ended May 31st, 1900, from pig iron made in Canada—
2,973.54 tons @ $3 ..... 8,920.60

$10,121.10

Bounty on Steel Ingots.

NOVA SCOTIA STEEL CO.—
Production during 12 months ended May 31st, 1900, from pig iron not less than 50 per cent. of which was made in Canada—
21,453.43 tons @ $3 ..... 64,360.29

Bounty on Silver.

HALL MINES CO. ($17,482.07).—
Mined in 1898-9, 31,190 tons (proportion of $30,000, less $71.91, cost of inspection) 10,442.09
Portion of unexpended bounty of 1895-6 distributed under O.C. 6,699 95
Short paid on output of years 1895 to 1898, inclusive, as shown by inspection 340.03

BRITISH COLUMBIA SMELTING & REFINING CO.—
Portion of unexpended bounty of 1895-6 distributed under O. C., $648.81, less overpaid on output of years 1895 to 1898, $193 40 and cost of inspection $49.19 ..... 6,246.22

CANADIAN SMELTING WORKS—
Mined in 1898-9, 57,805 tons (proportion of $30,000 less cost of inspection, $29.35 ..... $19,456.65

TRADE IN MINING MACHINERY.

Coincident with this great expansion in mineral development there has naturally been a correspondingly heavy trade in supplying our mines, mills, and smelters with mining machinery and supplies, a business in which it is gratifying to observe our Canadian manufacturers have more than held their own. The manufacture of many lines of high-class mining machinery has grown rapidly during the last few years, and today we have throughout the Dominion a number of large establishments which in point of engineering skill, equipment, and capacity to turn out good work, will compare favourably with the large works of our enterprising neighbours across the line. Naturally, we are not yet able to fill all the varied requirements of our mines and smelters, and a very large trade is done with the United States and other countries. as a reference to the following official statistics of the imports during the year ended 30th June last, will show :—During this period there were imported under the free list, mining and smelting machinery of a value of $724,187, compared with $299,800 imported in 1899, $207,737 imported in 1898, and $128,780 brought in 1897. Of the free entries the United States supplied $680,250, compared with $283,481 in 1898; Great Britain $43,720 as compared with $16,380 in 1899. The distribution of this machinery was as follows :—

	1900.	1899.
Nova Scotia	$320,038	$ 24,243
British Columbia	182,087	88,911
Ontario	145,040	142,216
Quebec	30,661	26,621
New Brunswick	10,246	212
Manitoba	1,600	1,080
N.W. Territory	674	10,926
Yukon	33,841	5,591
	$724,187	$299800

These figures, however, convey but an approximate idea of the great importance of our mining industry in its relation to the trade and commerce of the country, for we find scattered throughout the Trade and Navigation Returns, numerous entries not included in my comparative statement. Here are a few culled at random :—

Diamond Drills (*not including motive power, which is dutiable*):

	1900.	1899.
For Province of Ontario.....	$17,940	.....
,, Nova Scotia	2,111	.....
,, British Columbia..	4,201	.....
	$24,252	$9,692

(Great Britain $1,030 ; United States $23,222.)

Stamp Mills, Ore and Rock Crushers, Cornish and Belted Rolls, Rock Drills, Air Compressors, Cranes, Derricks, and Percussion Coal Cutters :—

	1900.	1899.
Ontario.....	$20,683	.....
Quebec.....	1,548	.....
Nova Scotia.....	6,738	.....
Manitoba	4,123	.....
British Columbia.....	2,653	.....
Total	$35,745	$33,780

(Great Britain $365 ; United States $35,380.)

Wire Rope :—

	1900.	1899.
Ontario.....	$8,773	.....
Quebec	13,364	.....
Nova Scotia.....	16,271	.....
New Brunswick.....	3,230	.....
Manitoba	500	.....
British Columbia.....	33,367	.....
N. W. Territories	814	.....
Yukon.....	2,582	.....
Total	$78,901	$416,158

(From Great Britain $32,852 ; United States $46,037.)

These notes, hurriedly compiled, are presented in the hope that they may, perhaps, be of some service to the members.

B. T. A. BELL, *Secretary.*

OFFICERS AND COUNCIL

1901-2.

PATRONS:

His Excellency, Lord Minto, Governor-General.

The Right Honorable Sir Wilfrid Laurier, M.P., Etc.

HONORARY MEMBERS:

Hon. W. S. Fielding, M.P., Ottawa.

Dr. A. R. C. Selwyn, C.M.G., Vancouver.

John Birkinbine, M.E., Philadelphia, Pa.

OFFICERS:

Past Presidents.

Mr. John E. Hardman, S.B., M.E, Montreal, Que.

Mr. S. S. Fowler, S.B., E M., Nelson, B.C.

President.

Mr. Charles Fergie, S.B., M.E., Westville, N.S.

Vice-Presidents.

Mr. R. R. Hedley, Nelson, B.C.

Mr. Graham Fraser, New Glasgow, N.S.

Dr. Frank D. Adams, Montreal.

Mr. Jas McArthur, Sudbury, Ont.

Secretary.

Mr. B. T. A. Bell, Ottawa.

Treasurer.

Mr. J. Stevenson Brown, Montreal.

Council.

Mr. J. B. Hobson, M.E., Quesnelle, B.C.

Mr. W. F. Little, Anthracite, N.W.T.

Mr. E. B. Kirby, M.E., Rossland.

Mr. Bernard MacDonald, M.E., Rossland.

Prof. Courtenay, DeKalb, M.E., Kingston

Mr. P Kirkegaard, Deloro, Ont.

Mr. Major R. G. Leckie, Sudbury, Ont.

Mr R. G. McConnell, Ottawa.

Mr. George R. Smith, M.L.A., Thetford Mines, Que.

Mr James T. McCall, Montreal, Que.

Mr. J. Burley Smith, M.E., Montreal.

Mr. R. E. Chambers, M.E., Bell Island, Newfoundland.

Mr. D. W. Robb, Amherst, N.S.

Mr. Henry S. Poole, M.A., A.R.S.M., M.E., Halifax.

Mr. G. F. McNaughton, Forest Hill, N.S.

DECEASED MEMBERS:

G R. Coates, Mine Centre, Ont

James McGregor, Nanaimo, B.C.

W. J. Nelson, Montreal, Que.

Maurice A. Buck, Kaslo, B.C.

Col. T. J. Tuck, Sherbrooke, Que.

H. A. Budden, Montreal, Que.

James King, Quebec.

W. Barclay Stephens, Montreal.

James Foley, Montreal.

Dr. Carl Hoepfner, Hamilton, Ont.

Dr. G. M. Dawson, Ottawa, Ont.

Lionel H. Shirley, Montreal, Que.

James F. Lewis, Sherbrooke, Que.

LIST OF MEMBERS:

(AS AT 1ST AUGUST, 1901.)

Adams, Dr. Frank D.,
McGill University, Montreal, Que.

Adams, Capt. Robert C., *Mine Owner*,
45 Metcalfe Street, Montreal, Que.

Aldred, J. E.,
1724 Notre Dame Street, Montreal, Quebec.

Aldridge, W. H., *Metallurgist*,
Canadian Smelting Works, Trail, B.C.

Allan, Alexander B, *Ironmaster*,
7 Langside Crescent, Campside, near Glasgow, Scotland.

Allan, W. A.,
O'Connor Street, Ottawa.

Ami, Dr. Henry M., *Palaeontologist*,
Geological Survey, Ottawa.

Andrews, C. F., *Mining Engineer*,
Isaac's Harbour, Nova Scotia.

Armstead, Henry H., Jr., *Mining Engineer*,
267 Fifth Avenue, New York, N.Y.

Atkinson, D. C. T., B.A.Sc., M.E.,
Etchemin, Que.

Bacon, F.,
377 St. Paul Street, Montreal, Que.

Bacon, T. P.,
Secretary New Rockland Slate Co., 377 St. Paul St., Montreal, Que.

Baker, Hugh C., B A.Sc., *Mining Engineer*,
Republic Washington.

Becher, E. Lorne,
Deer Park Mine, Rossland, B.C.

Belcourt, N. A., K.C., M P.,
Central Chambers, Ottawa.

Bell, B. T. A.,
CANADIAN MINING REVIEW, Ottawa.

Bell, Dr. Robert, *Geologist*,
Geological Survey, Ottawa.

Bell, John W., *Mining Engineer*,
Stanley Mines, Idaho Springs, Colorado.

Bennett, Wm.,
Rosekear Fuse Works, Camborne, Cornwall, England.

Blackburn, R. L, *Mine Owner*,
Sussex Street, Ottawa.

Blakemore, Wm.,
10 St. Luke Street, Montreal, Que.

Blue, John, *Civil and Mining Engineer*,
Eustis Mining Company, Eustis, Que.

Bodwell, E. V., *Barrister*,
Victoria, B.C.

Bonner, W. T., *Mechanical Engineer*.
Montreal, Que.

Boss, J. E.,
National Trust Chambers, Toronto, Ont.

Braden, Wm., *Mining Engineer*,
Bruce Copper Mines, Bruce Mines, Ont.

Brainerd, Dwight,
Hamilton Powder Company, Montreal, Que.

Briedenbach, Theo., *Mine Manager*,
Rat Portage, Ont.

Brent, Charles, *Mining Engineer*,
Rat Portage, Ont.

Brigstock, R. W.,
Nelson, B.C.

Brock, R. W., *Geologist*,
Geological Survey, Ottawa, Ont.

Brooks, Franklyn,
Eugene Munsell & Co., 218 Water Street, New York, N.Y.

Brown, D. A,
634 Exchange Building, 53 State Street, Boston, Mass.

Brown, J. Stevenson,
Temple Building, Montreal, Que.

Brown, Thomas, *Assayer*,
Nelson, B.C.

Bruce, R. Randolph, B.A.Sc., M.E.
Peterborough, B.C.

Burchell, J. T.,
Cape Breton Coal Co., New Campbellton, Cape Breton.

Burritt, G. L,
Box 33, Halifax, N.S.

Carle, N. A.,
Canadian Rand Drill Co., Sherbrooke, Que.

Carlyle, W. A., *Mining Engineer*,
Minas de Rio Tinto, Province Huelva, Spain.

Carpenter, C. B. K.,
Petroleum Oil Trust, Limited, Gaspe, Que.

Carr-Harris, Professor, C. & M.E.,
Bathurst Village, New Brunswick.

Carr-Harris, Robert R., *Civil Engineer*,
Kingston, Ont.

Carriere, C. H., *Mechanical Engineer*,
Messrs. Carriere Laine & Co., Levis, Que.

Carruthers, Capt. Bruce,
Kingston, Ont.

Carry, H. E. C., *Civil and Mining Engineer*,
Barkerville, B.C.

Chalmers, W. J. *Mechanical Engineer*,
Allis Chalmers Company, 1425 Marguerite Building, Chicago, Ill.

Chambers, R. E., *Mining Engineer*,
Bell Island, Conception Bay, Newfoundland.

Champion, James, C. & M.E.,
Barkerville, B.C.

Chesterton, C. A.,
Rat Portage, Ont.

Chewett, J. H., C. & M.E.,
87 York Street, Toronto, Ont.

Cirkel, Fritz, *Mining Engineer*,
80 Stanley Street, Montreal, Que.

Clabon, A. B.,
Windsor Hotel, Montreal.

Clark, J. M., R.C., LL.B.,
Toronto, Ont.

Clark, F. Satchell, *Mechanical Engineer*,
Wm. Hamilton Manufacturing Co., Vancouver, B.C.

Clergue, F. H.,
Lake Superior Power Co., Sault Ste. Marie, Ont.

Cole, A. A., B.A.Sc.,
War Eagle Mine, Rossland, B.C.

Cooper, James,
James Cooper Manufacturing Co., Montreal, Que.

Coste, Eugene, *Mining Engineer*,
56 Coal and Iron Exchange, Buffalo, N.Y.

Cowans, J. R.,
Cumberland Railway & Coal Co., Springhill, N.S.

Cowie, F. W., *Civil Engineer*,
Dept. Public Works, Ottawa, Ont.

Cox, E. Strachan, *Mining Broker*,
Toronto, Ont.

Craig, W. Hixon, *Chemist*
Canada Iron Furnace Co., Midland, Ont.

Croasdaile, H. E.,
Nelson, B.C.

Crookston, A. W, *Mining Engineer*,
188 St. Vincent Street, Glasgow, Scotland.

Curran, Neil McLeod,
North Star Mining Co., Cranbrooke, B.C.,

Curtis, Smith,
Rossland, B.C.

Daly, E. A., *Mining Engineer*,
Present address not known.

Davys, M. S., C & M.E.,
Nelson, B.C.

Dawson, G. Herbert,
541 Hastings Street, Vancouver, B.C

Deacon, T R., O.L.S., *Civil Engineer*,
Rat Portage, Ont.

Dean, A. L., *Chemist and Metallurgist*,
Canadian Smelting Works, Trail, B.C.

Dean, John,
Hamilton Powder Co., Rat Portage, Ont.

DeCourtenay, H. W.,
86-88 McGill Street, Montreal, Que.

DeKalb, Professor Courtenay, *Mining Engineer*,
Boston, Mass.

Dick, Alexander, C. & M.E.,
Parry Sound, Ont.

Dick, Alexander,
Dominion Coal Co., Glace Bay, C.B.

Donald, James T., M.A., *Assayer*,
112 St. Francois Xavier Street, Montreal, Que.

Donkin, Hiram, *Civil Engineer*,
Glace Bay, Cape Breton.

Douglas, Dr. James, *Metallurgist*,
99 John Street, New York, N.Y.

Drummond, George E.,
Canada Iron Furnace Co., Canada Life Building, Montreal, Que.

Drummond, Hon. George A.,
Montreal, Que.

Drummond, John J., *Mining Engineer*,
Canada Iron Furnace Co., Midland, Ont.

Drummond, Thos. J.,
Canada Life Building, Montreal, Que.

Drury, H. A.,
Imperial Oil Co., St. John, New Brunswick.

Duncan, Capt. T. R.,
Duncan Mines, Limited, Nelson, B.C.

Dundee, Charles,
Dundee Gold Mining Co , Rossland, B.C.

Edwards, W. S , *Mining Engineer*,
29 Broadway, New York, N.Y.

Eustis, W. E. C.,
Eustis Mining Co., 55 Kilby Street, Boston, Mass.

Evans, J. W., *Civil and Mining Engineer*,
Deseronto, Ont.

Faribault, E. R., B.A.Sc., *Geologist*,
Geological Survey, Ottawa, Ont.

Farnum, E. C.,
General Manager, Copper King Mining Co., Eldorado, Ont.

Featherstonehaugh, R. D., *Mining Engineer*,
Atlin, B.C.

Fell, E. Nelson, A.R.S.M., *Mining Engineer*,
Athabasca Gold Mine, Nelson, B.C.

Fergie, Charles, *Mining Engineer*,
Intercolonial Coal Co., Westville, N.S.

Ferrier, W. F., B.Sc., F.G.S.,
War Eagle Con. M. & Dev. Co., Rossland, B.C.

Flaherty, R. H., *Mine Manager*,
Port Arthur, Ont.

Fowler, S. S., *Mining Engineer*,
London and B.C. Gold Fields, Limited, Nelson, B.C.

Fraser, Graham,
Nova Scotia Steel & Coal Co., New Glasgow, N.S.

Fraser, A. W ,
Leslie's Chambers, Ottawa, Ont.

Fuller, H. J.,
Fairbanks Company, 749 Craig Street, Montreal, Que.

Gallagher, W. H.,
Vancouver, B.C.

Galt, Elliott T.,
Alberta Railway & Coal Co., Lethbridge, N.W.T.

Gardiner, W. S ,
Montreal, Que.

Gaylord, F. B.,
Deseronto Iron Co., Deseronto, Ont.

Gibbs, Dr. W. T., *Metallurgist*,
Buckingham, Que.

Gibson, T. W., *Director of Mines*,
Toronto, Ont.

Gifford, J. R., *Mine Superintendent*,
Hall Mining and Smelting Co., Nelson, B.C.

Gilman, E. W., *Mechanical Engineer*,
Canadian Rand Drill Co., Montreal, Que.

Gillon, Douglas John, O.L.S.,
Fort Francis, Ont.

Gilpin, Dr. E., Jr., *Mining Engineer*,
Department of Mines, Halifax, N.S.,

Goodwin, Dr. W. L.,
Director School of Mining, Kingston, Ont.

Grammer, Wm. L., *Mining Engineer*,
Dom. Iron & Steel Co., Bell Island, Conception Bay, Newfoundland.

Green, George A.,
153 Drummond Street, Montreal, Que.

Grundy, Frank,
Quebec Central Railway, Sherbrooke, Que.

Gue, T. R., *Mine Owner*.
Acadia Powder Co., Halifax, N.S.

Guess, George A., *Mining Engineer*,
Greenwood, B.C.

Guess, H. A., M.A., *Mining Engineer*,
Ottawa Gold Milling & Mining Co., Keewatin, Ont.

Gwillim, J. C., B.A.Sc., *Mining Engineer*,
Ottawa, Ont.

Haggen, E. A., *Mining Engineer*,
Revelstoke, B.C.

Hamilton, Wm., Jr.,
Wm. Hamilton Manufacturing Co., Peterborough, Ont.

Hammond, Herbert C.,
Osler & Hammond, Toronto, Ont.

Hansen, C. C., *Mechanical Engineer*,
James Cooper Manufacturing Co., St. Henri, Que.

Hardie, W. D. L., *Colliery Manager*,
Lethbridge, N.W.T.

Hardman, John E., S.B., *Mining Engineer*,
Room 3, Windsor Hotel, Montreal, Que.

Harris, J. M., *Mine Owner*,
Reco Mining & Milling Co , Sandon, B.C.

Harris Ronald, *Mining Engineer*,
Greenwood, B.C.

J. B. Hastings, *Mining Engineer*,
20 Broad Street, New York, N.Y.

Hay, A. Marshall, *Mine Owner*,
Port Arthur, Ont.

Heal, John H., *Mining Engineer*,
Three Forks, B.C.

Hedley, R. R., *Metallurgist*,
Hall Mining & Smelting Co , Nelson, B.C.

Hersey, Milton L., *Assayer*,
146 St, James Street, Montreal, Que.

Higginson. J. F., *Mine Owner*,
Buckingham, Que.

Hill, Leslie, C. & M.E.,
519 Hastings Street, Vancouver, B.C.

Hille, F., *Mining Engineer*,
Port Arthur, Ont.

Hixon, Hiram W., M.E.,
Mond Nickel Co., Whitefish, Ont.

Hobson, John B., M.E.,
Con. Cariboo Hydraulic Mining Co., Quesnelle Forks, B.C.

Hodges, A. B. W., *Mine Superintendent*,
Granby Con. M. & Smelting Co., Grand Forks, B.C.

Holland, W. H.,
Victoria Mine, Whitefish, Ont.

Hopkins, Frank H.,
Dominion Wire Rope Co., Montreal, Que.

Hopkins, Gerald V., *Metallurgist*,
B.C. Bullion Extraction Co., Silica, B.C.

Hoppel, R. T.,
Canada Life Building, Montreal, Que.

Hughes, G. W., *Mine Manager*,
Idaho Mines, Idaho Basin, B.C.

Hungerford, W. A.,
Atlas Arsenic Co., Deloro, Ont.

Hunter, M. T.,
Wendigo Gold Mining Co., Rat Portage, Ont.

Jaffray, Robert,
44 Victoria Street, Toronto, Ont.

Jeffery, W. H., *Mining Engineer*,
Kaslo, B.C.

Jenckes, S. W., *Mechanical Engineer*,
Sherbrooke, Que.

Jenckes, J. M ,
Jenckes Machine Co., Sherbrooke, Que.

Jennings, E. T., M.E.,
319 Fourth Street, Salt Lake City, Utah.

Jennings, W. T., C E.,
Molson's Bank Building, Toronto, Ont.

Johnson, Paul, *Metallurgist*,
British Columbia Copper Co., Greenwood, B.C.

Johnston, R. C. Campbell, *Mining Engineer*,
Nelson, B.C.

Johnstone, James, C.E.,
Crow's Nest Pass Coal Co., Fernie, B.C.

Keffer, Frederick, *Mining Engineer*,
British Columbia Copper Co., Anaconda, B.C.

Kehoe, Henry, *Mining Engineer*,
218 7th Avenue, Spokane, Washington.

Keith, Walter S., M.E., *Mining Engineer*,
Greenwood, B.C.

Kendall, E. F., *Mine Owner*,
Rat Portage, Ont.

Kerr, David G., *M.* & *Mechanical Engineer*,
Cordova Exploration, Limited, Marmora, Ont.

King, Lt.-Col., *Mine Owner*,
Sherbrooke, Que.

Kinghorn, J. P.,
105 West George Street, Glasgow, Scotland.

Kirby, Edmund B., *Mining Engineer*,
War Eagle Con. Mining and Dev. Co., Rossland, B.C.

Kirkegaard, P., *Mine Manager*,
Canadian Gold Fields, Limited, Deloro, Ont.

Knobel, H. E.,
Rat Portage Ont.

Knox, John, *Mining Engineer*,
Calumet, Michigan.

Koehler, Wm., *Chemist and Metallurgist*,
1614 Superior Street, Cleveland, Ohio.

LaBeree, Edwin E.,
193 Sparks Street, Ottawa, Ont.

Latimer, F. H., *Civil Engineer*,
Vernon, B C.

Law, Chas. F.,
Box 116, Vancouver, B.C.

Lawrence, H. D.,
Sherbrooke, Que.

Lawson, Capt. John, *Mine Manager*,
Copper Cliff, via Sudbury, Ont.

Lay, Douglas, *Analytical Chemist and Assayer*,
Kimberley, B.C.

Leckie, J. E , *Mining Engineer*,
Greenwood, B.C.

Leckie, Major R. G., *Mine Owner*,
Sudbury, Ont.

Leckie, Major R. G. Edwards, M.E.,
At present in Norway.

Ledoux, Dr. A. R., *Metallurgist*,
99 John Street, New York, N.Y.

Leonard, R. W., C.E.,
Montreal West, Que.

Little, W. F., *Mine Manager*,
H. W. McNeill Co., Limited, Anthracite, N.W.T.

Libbey, Wilbur L.,
Brookfield Mining Co., N. Brookfield, Nova Scotia.

Loring, Frank Co., *Mining Engineer*,
45 Broadway, New York, N.Y.

Low, Albert P., B.A.Sc., *Geologist*,
(Present in Labrador).

Macdonald, A., *Mine Owner*,
St. Johns, Que.

Macdougall, George,
85 Osborne Street, Montreal, Que.,

Macnutt, Charles H., *Mining Engineer*,
c/o Huanchaca de Bolivia, Pulacayo, Bolivia, South America.
via Autofagasta, Chili.

Mann, D. D ,
Messrs Mackenzie, Mann & Co., Toronto, Ont.

Marks, George T., *Mine Owner*,
Street Railway Chambers, Toronto.

Mason, F. H., F.G.S., *Assayer*,
Queen Building, Halifax, N.S.

Maze, C. D., *Civil Engineer*,
597 Sherbrooke Street, Montreal.

Meissner, C. A., *Mining Engineer*,
Sydney, Cape Breton.

Melville, John F.,
Rat Portage, Ont.

Mendenhall, F. R., *Mechanical Engineer*,
Rossland, B.C.

Meredith, Robert,
51 St. Francois Xavier, Street, Montreal, Que.

Meyer, Leopold, *Mining Engineer*,
Madoc, Ont.

Meyer, Charles, *Mining Engineer*,
Victoria Chambers, Ottawa, Ont.

Michell, H. C ,
24 Old Broad Street, London, E C., England.

Mickle, G. R., *Mining Engineer*,
School of Practical Science. Toronto, Ont

Milbourne, C. K ,
Oaklands, West End, Hants, England.

Miller, Spencer, *Civil Engineer*,
Lidgerwood Manufacturing Co , 196 Liberty Street, New York, N.Y.

Miller, Professor W. G., *Geologist*,
School of Mining, Kingston.

Mitchell, G. W.,
33 Cooper Street, Ottawa, Ont.

Mitchell, James S., *Mine Owner*,
Sherbrooke, Que.

Morgan, C. W., *Mechanical Engineer*,
Northey Manufacturing Co., Toronto, Ont.

Morris, A. W.,
Montreal, Que.

Morse, Willard S., *Mining Engineer*,
c/o Messrs. M. Guggenheim's Sons, 30 Broad St , New York, N.Y.

Moxham, A. J.,
Dominion Iron & Steel Co., Sydney, Cape Breton.

Musgrave, Edward C., *Mining Engineer*,
Duncan's Station, B.C.

Mussen, H. W. C.,
763 Craig Street, Montreal, Que.

McAree, John, P.L.S.,
Rat Portage, Ont.

McArthur, James, *General Manager*,
Canadian Copper Co., Sudbury, Ont.

McAvity, Geo. S.,
St. John, New Brunswick.

McCall, J. T.,
Canada Life Building, Montreal, Que.

McConnell, R. G., *Geologist*,
Geological Survey, Ottawa, Ont.

McConnell, Rinaldo, *Mine Owner*,
175 Cooper Street, Ottawa, Ont.

McCuaig, Clarence J.,
London & Lancashire Building, Montreal, Que.

McDonald, Bernard, *Mining Engineer*,
Rossland Great Western Mines, Limited. Rossland, B C.

McDonald, D. J., *Mining Engineer*,
Rossland, B.C.

McDonnell, James A.,
c/o Bank of Montreal, Nelson, B.C.

McEvoy, James, *Geologist*,
Crow's Nest Pass Coal Co., Fernie, B.C.

McInnes, Wm., *Geologist*,
Geological Survey, Ottawa, Ont.

McLennan, John S.,
Glace Bay, Cape Breton.

McMillan, N., *Mine Manager*,
Mikado Gold Mining Co., Rat Portage, Ont.

McNaughton, G. F., *Mine Manager*,
Forest Hill, N.S.

McNaughton, A. G., *Mine Manager*,
Blue Nose Gold Mining Co., Goldenville, N.S.

McNeill, A., *Barrister*,
Metropole Building, Halifax, N.S.

Newman, W. T.,
Box 81, Vancouver, B.C.

Nichols, Horace G., *Mining Engineer*,
Ymir, B.C.

Nichols, W. H., *Mine Owner*,
Nichols Chemical Co., 11 Broadway, New York, N.Y.,

Noble, A. E.,
Woodstock Iron Works, Anniston, Alabama.

Northey, John *Mechanical Engineer*,
Northey Manufacturing Co., Toronto, Ont.

Obalski, J., *Inspector of Mines*,
Quebec, Que.

Palmer, R. E., M.E.,
Minas de Rio Tinto, Province Huelva, Spain.

Parker, Chas., M.E.,
Nelson, B.C.

Parker, J. L., M.E.,
North Star Mining Co., Cranbrooke, B.C.

Parrish, S. F., *Mining Engineer*,
B.C. Chartered Co., Limited, Eholt, B.C.

Patterson, H. E. C.,
Box 305, Rat Portage, Ont.

Patterson, John,
Dominion Copper & Nickel Co., Hamilton Ont.

Peacock, Francis T., *Mechanical Engineer*,
204 St. James Street, Montreal, Que.

Peacock, B. F.,
4169 Dorchester Street, Montreal, Que.

Penhale, John J., *Mine Manager*,
Black Lake, Que.

Plummer, Frank,
Whitby, Ont.

Poole, Henry S., M.A , A.R.S.M., M.E.,
162 Pleasant Street, Halifax, N.S.

Porter, John B ,
McGill University, Montreal, Que.

Preston, W. A.,
Harding P.O., Minnesota, U.S.A.

Pyke, J. W.,
205 St. James Street. Montreal, Que.

Reed, Dr. James, *Mine Owner*,
Reedsdale, Que.

Robb, D. W., *Mechanical Engineer*,
Robb Engineering Co., Amherst, N.S.

Robertson, J Roderick,
London & B.C. Gold Fields Limited, Nelson, B.C.

Robertson, W. F.,
Provincial Mineralogist, Victoria, B.C.

Robins, Frank C., *Mining Engineer*,
Kimberley, B.C.

Robinson, A. H. A., *Mining Engineer*,
Peterborough, Ont.

Rodden, W. T.,
Hamilton Powder Co., Montreal, Que.

Ross, A. C.,
North Sydney, Cape Breton.

Ross, Robert B.,
35 St. Francois Xavier Street, Montreal, Que.

Ross, G. J., *Mechanical Engineer*,
Sydney, C.B.

Roughsedge, Dr. W. H., *Mine Owner*,
Holbrook's Chambers, Ottawa, Ont.

Rykert, E. G.,
London & Lancashire Building, Montreal Que.

Sanders, W. A., *Mining Engineer*,
2406 Sutter Street, San Francisco, California.

Scovil, Dr. S. S., *Mine Manager*,
Rat Portage, Ont.

Sexton, D. M.,
3 St. Sacrament Street, Montreal, Quebec.

Sharp, Alexander, *Mine Superintendent*,
Rossland, B.C.

Shirley, F. Stacey,
Glen Almond Mica & Mining Co., Glen Almond, Que.

Simpson, S. J ,
Jas. Cooper Manufacturing Co., Montreal, Que.

Sjostedt, E. A., *Metallurgist*,
Sault Ste. Marie, Ont.

Smillie, Dr. N. C ,
Temple Building, Montreal, Que.

Smith, Daniel,
Ontario Powder Works, Kingston, Ont.

Smith, George R , M L.A., *Mine Manager*,
Bell's Asbestos Co., Thetford Mines, Que.

Smith, Frank B., *Mining Engineer*,
Fernie, B.C.

Smith J. Burley, *Mining Engineer*,
147 Stanley Street, Montreal.

Smith, M. T., *Mine Owner*,
Greenwood, B.C.

Smith, Chas. F ,
McCready & Co., Montreal, Que.

Smith, Jacob, C E ,
Department of the Interior, Ottawa, Ont.

Snyder, F T., *Mechanical Engineer*,
324 Dearborn Street, Chicago, Ill.

Speller, F. N.,
Bureau of Mines. Toronto, Ont.

Stevenson, A. W., C.A ,
Bank of Toronto Chambers, Montreal, Que.

Sullivan, Alan, *Mine Manager*,
Anglo Canadian Gold Estates Co., Limited, Rat Portage, Ont.

Sutton, W. T , *Mining Engineer*,
89 Discovery St., Victoria, B.C.

Sweny, Roy,
Roy Mine, Sawbill P.O., Ont.

Swinney, A. J. G.,
Lorne Villa, Sidcup, Kent, England.

Sword, James D , *Mining Engineer*,
Nelson, B.C.

Stewart, D. E. K., *Barrister*,
Madoc, Ont.

Taylor, C. H , *Mechanical Engineer*,
Taylor Hydraulic Air Compress r Co., Notre Dame St., Montreal, Que.

Thomas, D. R., C. & M.E.,
Athletic Club, Rossland, B.C.

Tompkins, C. H.,
American Diamond Rock Drill Co., 120 Liberty St.; New York, N.Y.

Topping, Col. E. S , *Mine Owner*,
Trail, B.C.

Townsend, George, *Mine Manager*,
Castle Mining Co., Rossland, B.C.

Turner, A. P.,
Canadian Copper Co., Copper Cliff, via Sudbury, Ont.

Tyrrell, J. B., M.A., F.G S , *Mining Engineer*,
Dawson City, Yukon, Canada.

Warden, Bruce, *Mining Engineer*,
War Eagle Con. Mining & Dev. Co., Rossland, B.C.

Walsh, E. J., C.E.,
Anglo Canadian Lead Syndicate, Lake Temiscamingue, Que.

Weller, Harry. Wray, *Mechanical Engineer*,
202 St. James Street, Montreal, Que.

Wells, J. Walter, *Assayer*,
Provincial Assay Office, Belleville, Ont.

Wells, Fred. M.,
Republic, Washington.

White, Bruce, *Mine Manager*,
Nelson, B.C.

Whiteside, O. E. S , *Mining Engineer*,
Anthracite, N.W.T.,

Whitney, H. M ,
President, Dominion Coal Co., 95 Milk Street, Boston, Mass.

Wiley, F. S , *Mine Owner*,
Port Arthur, Ont.

Williams, J. N S., C. & M.E.,
Honolulu, Hawaii Islands.

Wilkinson, C. H ,
222-224 Dashwood House, 9 New Broad St., London, E.C., England.

Willson, Alfred,
Commissioner, Canada Company, Toronto, Ont.

Wilson, F. C.,
c/o Messrs. A. R. Williams & Co., 320 St. James St., Montreal, Que.

Wilson, Harry, *Mining Engineer*,
1570 Ontario Street, Montreal, Que.

Woakes, Ernest. *Mining Engineer*,
Duncan Mines, Limited, Nelson, B.C.

Wright, Lieut.-Col. Joshua,
43rd Milling & Mining Co., 193 Sparks Street, Ottawa, Ont.

Wright, Sydney B., *Chemist and Metallurgist*,
Canadian Gold Fields, Limited, Deloro, Ont.

Wright, A. W.,
Sandon, B.C.

STUDENT MEMBERS.

Ainley, Chas. N., B.A.Sc.,
Almonte, Ont.

Atherton, H. Stanley,
13 Mawdsley Street, Bolton, England.

Blaylock, Selwyn G.,
Canadian Smelting Co., Trail, B.C.

Butler, Percy,
Box 14, Perth Amboy, New Jersey, U.S.A.

Campbell, N. M., M.E.,
68 St. Famille Street, Montreal, Que.

Grant, G. Harold,
c/o Capt. Wm. Grant, Point Ellice, Victoria, B.C.

Kirkpatrick, Stafford F.,
96 Barrie Street, Kingston, Ont.

MacInnes, H W.,
Waverly Gold Mining Co., Waverly, N.S.

Preston, John C ,
c/o Dominion Coal Co., Glace Bay, Cape Breton.

Scott, O. N.,
228 Johnston Street, Kingston, Ont.

Stevens, F. G., B.Sc.,
British American Corporation, Rossland, B.C.

Yuile, N. M.,
North American Glass Works, Montreal, Que.

TN
1
C2
v.4

Canadian Institute of Mining and Metallurgy
Transactions

Engin.

ENGIN STORAGE

PLEASE DO NOT REMOVE
CARDS OR SLIPS FROM THIS POCKET

UNIVERSITY OF TORONTO LIBRARY